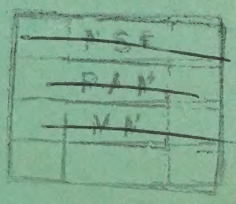
FEDERAL REPUBLIC OF NIGERIA

Annual Report on the Federal Department of Agricultural Research

FOR THE YEAR 1968-69



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ANNUAL REPORT

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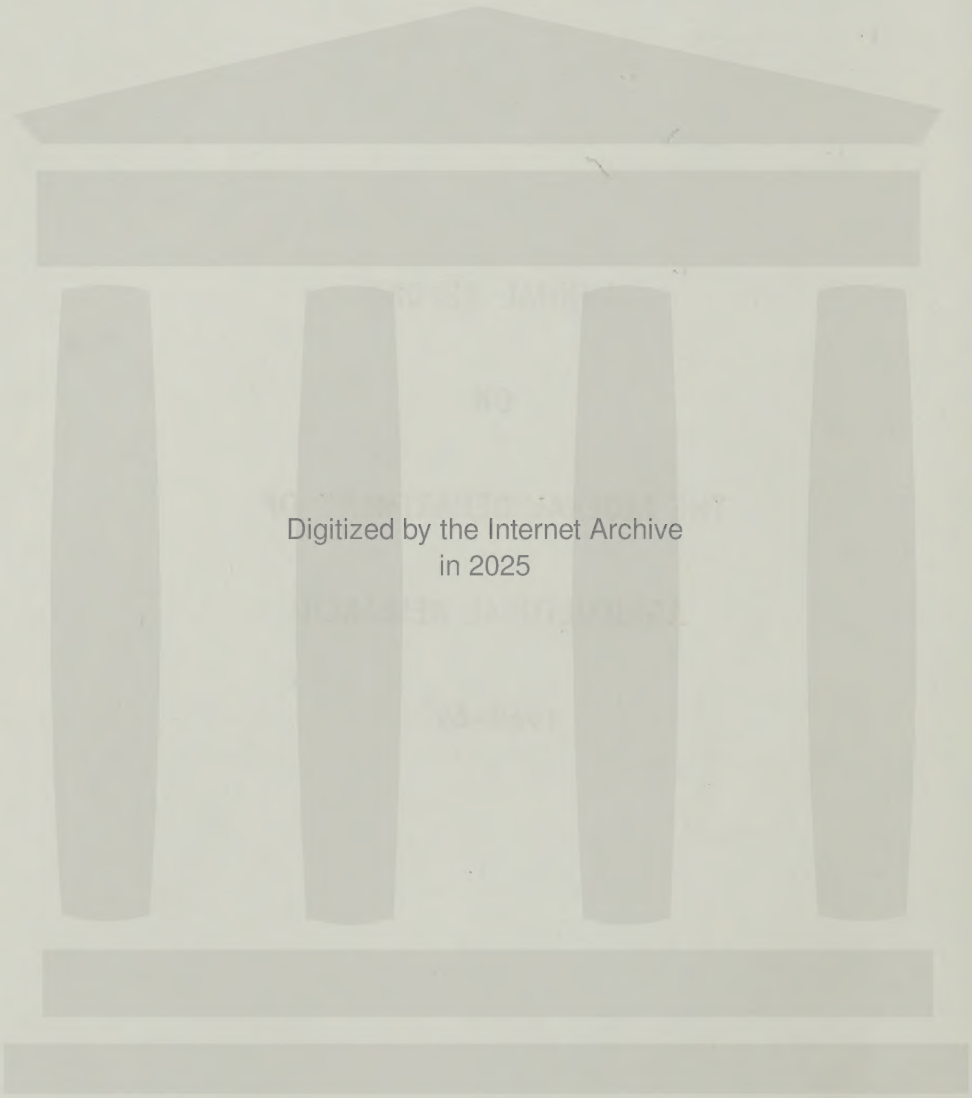
THE FEDERAL DEPARTMENT OF

AGRICULTURAL RESEARCH

1968–69



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ANNUAL REPORT ON THE DEPARTMENT OF AGRICULTURAL RESEARCH FOR THE YEAR 1968-69

THE DIRECTOR OF AGRICULTURAL RESEARCH SYNOPSIS

INTRODUCTION

Policy and Development

The established policy of the Federal Department of Agricultural Research to raise the productivity of Nigeria's staple food crops by actively pursuing research into the improvement of the plant material, the control of plant diseases and pests and ameliorating the soil for better nutrition of the plant, was during this period aptly reflected in the research programmes which were vigorously pursued to the extent permitted by available staff and facilities. The continuation of the civil war in the country has been a serious hindrance to the successful implementation of the research programmes in the Eastern States. Also, the loss of a number of experienced senior staff who were trapped within the rebel enclave limited the Department's activities and progress considerably. In spite of the setback, the Department was able to meet the challenge of its responsibility throughout the period 1968-69.

Collaboration in research activities was maintained with the State Ministries of Agriculture in the Federation.

Review of Research

Crop Improvement

A wide range of investigations was carried out successfully during 1968. The National Zonal Maize Variety Trials were conducted to select varieties most promising and adapted to the maize growing areas in each of the States in the country. A number of maize varieties were recommended to the different states on the basis of high yield, grain type and resistance to rust and blight diseases. Thus, the improved yellow flint variety NS-1 was recommended to the Western, Midwestern, Kwara, North-Western, North Central, Kano, North-Eastern and Benue-Plateau States while the white dent floury variety NS-5 was recommended to the Western, Midwestern, Kwara, North Central and Kano States. On the other hand, the introduced white floury dent variety H-503 was recommended to North-Western State while Diacol V-153 was recommended to the Midwestern, Kwara, North Central, Kano, North-Eastern and Benue-Plateau States.

The continuation of the civil war, made it impossible to conduct the trials in the Eastern States in 1967 and 1968. Hence no recommendations could be made for the three Eastern states. Before the recommendations were made, all the varieties were subjected to acceptability tests by consumers.

In 1968, intensive research was continued with the aim of producing better varieties of rice **(Oryza sativa)** suitable to the varied ecological conditions of rice growing areas. At Birnin Kebbi, Indo-Chine Blanc was found to be the significantly highest yielding variety, with a maturity period of 37 days earlier than the recommended variety, Mali-Ong, but having an inferior floating habit than the latter. Attempts made at finding best rice varieties which will be suitable for raising two rice crops in a year, resulted in the selection of the following combinations on the basis of maximum yields, among other characteristics:

(1) Taichang Native 1 followed by IR-5 or SML 140/5, and

(2) IR-8 followed by SML 140/5 or IR-5.

Attempts were made during the year to improve the techniques of parboiling and milling of grain of different varieties of rice. Interesting correlations were observed between the soaking period, steeping temperatures and grain size. These factors appear to affect significantly the milling quality of the varieties tested. The best condition for reducing the percentage of broken grain in the milled SML rice varieties to a minimum was soaking for six hours at 70°C.

The National Zonal upland rice variety trials conducted between 1963 and 1965 led to the recommendation of OS-6 in the southern states of Nigeria to replace the previously recommended variety Agbede 16/56. Similar trials conducted in 1964-65 gave encouraging results for the recommendation of OS-6 as upland variety for southern Zaria province of the former Northern Nigeria. Under the rainfed upland condition of the riverine provinces in the savannah zone the result of trials since 1966/67 series indicated that variety E.425, which is of shorter duration than OS-6, has a greater yield potential than OS-6 in areas where rain water was limiting.

Studies aimed at improving the dry matter and crude protein contents of pasture legumes were initiated during the year, employing a technique of seed inoculation, with effective strains of Rhizobium isolated locally. The inoculated plants yielded nearly 4 times the dry matter and over 5 times the nitrogen content of the uninoculated controls.

Investigations were continued on the search for cassava hybrids having improved yields and mosaic resistance. New and high yielding acquisitions: 671284, 671285, 671286 and 671289 are being currently compared with the recommended high-yielding varieties: 53101, 60444, 60447 and 60506.

Crop Protection

Much of the work of the Entomology Division in 1968 was directed primarily towards obtaining a clearer and more accurate knowledge of the life history and movements of the pests of important agricultural crops in Nigeria. Work has commenced in the field of sugar cane nematodes which were hitherto untouched. The study of a wide range of pesticides was undertaken following information on the detailed life history of pests of crops such as rice (upland and swamp), cowpeas, citrus, yams and sugar cane. These studies are essen-

tial to the economic justification of any recommendation for large scale use of chemical pesticides.

The Plant Pathology Division has continued efforts to evolve a standard scale for measuring the intensity of brown leaf spot infection caused by *Helminthosporium oryzae* which appears to be remarkably very important on upland rice in Nigeria. Forty rice varieties were screened for resistance to **Helminthosporium sp.** attack. Three swamp rice varieties, namely, SML 140/10, SML-18-B and Mali Ong were found to be resistant; eight upland rice varieties, including the newly recommended OS-6, were moderately resistant while the remaining varieties including OS-4, E425 and the local Agbede 16/56 were susceptible.

Crop Nutrition

The Soil Fertility and Chemistry Division is now able to render analytical service involving a wide range of determinations of major and minor elements. The Large and the Medium Hilger Quartz Emission Spectrographs were in full operation, during the year, thereby making it possible to analyse soil/plant materials as well as mineralogical samples for detailed trace-element analysis.

The overall problem of soil fertility, as influenced by climatic factors and farming systems is being currently attacked from several angles. Specific studies of plant nutrition capable of throwing important light on fundamental problems facing agriculture under humid tropical zones of Nigeria have also been taken up.

The Maize and Legumes Division have actively pursued agronomic investigations involving weeding methods and chemical weed control. Important parameters for legumes were also investigated, e.g. optimum time of planting cowpeas and effect of a leguminous cover crop on soil nitrogen status and maize nutrition.

Investigation into dry matter and starch contents in yam tubers in NPK trials were conducted by the Rice and Root Crops Division. No significant differences were observed in the amount of these constituents. There was, however, remarkable decrease in starch percentage at higher levels of nitrogen and phosphorus. It would appear that the lower levels of both nitrogen (30 lb/acre N) and phosphorus (20 lb/acre P_2O_5) gave best results. It was also found that weight loss, in stored yams, was significant in tubers which had received higher level of phosphorus (40 lb/acre (P^2O_5) than in those which had lower level (20 lb/acre P_2O_5) or none at all.

In cassava research, interesting data have been obtained on the yield of starch in relation to harvesting time. Thus, highest yield of starch was obtained when harvesting was done at 18 months. The results of these studies, when confirmed, will be valuable to the practical farmer.

Important correlations have been obtained between the yield of swamp rice varieties of differing growth habits with increasing rates of application of nitrogen. Thus, IR-8, a dwarf variety, continued to give higher yield at higher doses of 4½ and 6 cwts. per acre of sulphate of ammonia. For the same doses of nitrogen, yield was depressed in the

case of Mas 2401, a tall, weak-strawed lodging variety, while for SML 140/10, a medium tall erect-growing type, the yield, for reasons which cannot be explained yet, initially decreased between the doses of 3 and 4½ cwts but again increased significantly at 6 cwts per acre of ammonium sulphate. Interesting data have been obtained on the method of fertilizer-nitrogen application in swamp rice. There was evidence from plant height and yield data that subsurface placement of fertilizer pellets at 6 inches deep was superior to other methods of application. The yield increases were of the order of 31% over the control.

Conclusion

It is to be expected that the results of these investigations and the recommendations emanating therefrom, would go a long way in improving farming practices and farm yields. In accepting new techniques for the modernization of agriculture in this country, much would, naturally, depend on the cooperation and activities of the Extension Services in making research findings and recommendations available to the farmers in a language easily intelligible to them. This Department will intensify efforts to carry out its responsibility of collating and disseminating research findings, particularly from the various sources within the country.

—Director of Agricultural Research

MAIZE BREEDING

Heritability trials

The main objective of the trials were to test the general combining abilities of the local varieties and determine their heritability. The inbred-variety crosses were grown in randomized block experiment with four replications in 1966 and 1967 at Moor Plantation, Ibadan. Table 1 gives the mean grain yields in pound per acre for the males (testers), females (locals), interaction and the summary of the statistical analyses:

Table 1: Means of grain yield lb/acre for the males (testers), females and interaction

Males	*Females*						
	Ugep white	*Akwete white*	*Ikom white*	*Bende white*	*Lagos white*	*Bende white*	*Male Means*
Sicaragua	3285	3445	3375	2760	2217	2702	2966
Eafro 231	2815	2495	2277	2522	2845	2250	2536
Female Means	3050	2970	2826	2641	2531	2476	2751

Standard deviation = 144, CV. = 5.2%

Sources	*S.E.*	*L.S.D.* (0.05)	*L.S.D.* (0.01)
Reps.	41.1	NS	NS
Males	29.4	NS	NS
Females	50.9	NS	NS
Males × Females	71.8	207.2	277.3

The calculations of heritabilities for grain yield gave 0%, 27% and 80% for the local, introduced and the interaction between the two sets of varieties, respectively.

The results reported above are highly interesting since 0% heritability of the local varieties gives a clue to the low grain yields usually recorded. On the other hand, inspite of the fairly low heritability (27%) recorded for male testers, the interaction effect had 80%. This suggests the magnitude of the heterotic effect expected whenever a local maize variety is crossed to an introduced one with contrasting heritabilities.

Prediction of grain yields of double crosses from single crosses

In 1968, the accuracy of the prediction was tested in a field experiment. Table 2 gives a comparison of grain yield per acre of the six double crosses in a simple randomized block trial with four replications.

Table 2: Grain yields lb/acre (12% moisture) of six double crosses obtained at Ibadan, Early season, 1968.

Double Crosses	*Actual grain yield*, 1968	*Predicted yield based on single cross performance in* 1967
(Eafro 231 × (Diacol) × (H.503 × Sicaragua)	5716	4315
(Sicaragua × Eafro 231) × (H. 503 × H. 507)	5129	4344
(Eafro 231 × H. 507) × (H. 503 × Lagos white)	4904	4027
(H. 503 × Sicaragua) × (H. 507 × Eafro 231)	4644	4352
(H. 507 × Eafro 231) × (Ugep white × B. white)	4360	3837
(H. 503 × H. 507) × (B. white × Bende Local)	4122	3786
Mean	4812	4110

The method of prediction was found to be quite satisfactory. The selected progenies from the trial have been entered in the production of white maize composite C.

National Zonal Maize Variety Trials

The main objective of conducting the national Zonal maize variety trials is to select varieties most promising and adaptable to the maize growing zones within the country. In these trials the varieties which form the treatments were selected on the basis of desirable

agronomic and genetic features, e.g. high yield, grain type of resistance to rust and blight shown in breeders' trial plots. At each site the same varieties and the same design (randomized block in four replications) were used. The local variety from the site was the control. The varietal mean yields in the Northern, Western and Midwestern States are shown in Tables 3-5 below:

Table 3: Mean grain yields (lbs per acre) at 12% moisture of 11 varieties at nine sites in the Northern States in 1968

Varieties	*Tumu*	*Samaru*	*Biu*	*Mokwa*	*Osi*	*Hong*	*Oturkpo*	*Riyom*	*Ochaja*	*Mean*
Composite A & B	5869	5997	4368	3544	3616	3001	3289	3034	2665	3931
Composite A	6636	5784	4514	3676	3556	3199	2609	2618	2857	3828
Bulk-3	5939	5748	3450	3934	3204	2934	3062	2735	2112	3690
Diacol-V 153	6787	4730	4758	3321	2941	2849	2533	2828	2307	3673
Dahomean Composite	5762	5012	4073	2679	2671	3766	2514	2415	2374	3485
NS-5	5785	5316	2877	3800	2979	3176	2520	2634	2275	3474
Eafro 231	6008	3387	3727	4344	3779	3297	2117	2166	2155	3431
NS-1	5741	4762	2759	4061	3034	2275	2533	2347	2646	3350
H.503	6485	4635	3641	3097	3514	2510	2061	1981	1407	3260
H.507	6354	3382	3491	3582	3217	1821	2117	2259	1968	3132
Locals	5395	4658	3881	3229	2168	3076	1626	1446	1953	3048
Mean	6069	4855	3776	3570	3161	2800	2444	2415	2247	3482
S.E.	326	334	390	360	203	330	233	148	330	163
C.V. %	10.8	13.8	20.7	20.2	12.8	23.6	19.1	12.4	19.3	14.1
L.S.D. at 5%	904	935	1092	998	568	923	651	411	915	453

It may be seen from Table 3 that in the Northern States the yellow flint cultivars composite A & B, Composite A and Bulk 3 were higher yielding, on the average, at all the sites than the white floury flint varieties NS-5 and Eafro 231. There were significant interactions between the varieties and the sites. For example, the variety Eafro 231 gave 6008 lbs/acre at Tumu but only 2,155 and 2,117 lbs per acre at Ochaja and Oturkpo, respectively.

Table 4: · Mean grain yields (lbs per acre) at 12% moisture of 11 varieties at five sites in the Western State in 1968.

Varieties	*Akure*	*Ilora*	*Ondo*	*Ibadan*	*Ipokia*	*Mean*
Bulk-3	5732	5191	4409	4223	1925	4296
Diacol V-153	6284	4464	4658	3741	1335	4096
Composite A	4855	4344	4506	4508	2028	4048
H. 507	5036	4900	4204	4007	839	3797
Composite A & B	4734	3545	4295	4398	2004	3793
NS-1	5447	3480	3917	3875	1899	3733
H. 503	4719	3713	4635	4465	976	3702
Eafro 231	4719	3713	4635	4465	1872	3652
NS-5	4787	3640	3509	3696	1243	3375
Dahomean Composite	4416	3191	3316	3578	1048	3110
Locals	3993	3042	1815	2348	1381	2516
Mean	5023	3949	3924	3833	1505	3647
S.E.	341	260	212	235	257	211
C.V. %	13.4	18.8	11.4	12.4	34.2	15.9
L.S.D. at 5%	958	767	593	653	718	608

In the Western State (Table 4), only Bulk-3, a yellow flint variety was superior, though not significantly, to the white floury flint variety Diacol V-153. Significant interaction between variety and sites were indicated.

Table 5: Mean grain yields (lbs per acre) at 12% moisture of 8 varieties at three sites in the Midwestern State in 1968.

Varieties	*Obior*	*Agbadu*	*Ofori*	*Mean*
NS-1	3373	1545	2004	2307
Bulk-3	3221	2132	1565	2306
Eafro 231	3085	2023	1414	2174
Diacol V-153	2851	1710	1656	2072
H. 503	1898	1741	1338	1659
NS-5	2238	1701	907	1615
H. 507	2321	1357	1096	1591
Local	2208	1267	1134	1536
Mean	2649	1685	1389	1908
S.E.	315	234	118	172
C.V. %	24.1	28.1	17.9	15.4
L.S.D. at 5%	872	647	327	521

In the Midwestern State, the two yellow flint varieties NS-1 and Bulk-3 gave better grain yields than any of the white grain varieties on average over all the sites in the State.

In the Northern, Western and Midwestern States, the highest yielding maize varieties were 29, 75 and 57 per cent, respectively better than the local varieties.

Acceptability Tests: A general survey of consumers and growers preference for the high-yielding varieties revealed a considerable degree of variation. Thus, in the Northern States, the introduced varieties H. 503, Diacol V-153 and H. 507 had the highest ranking. However, the local variety was preferred to the white maize varieties at Akwanga village and town in the Benue-Plateau State. In the Western State generally, the consumers preferred the bred variety NS-5, a white floury variety. On the other hand, in the Midwestern State, the most liked variety was the local white maize. The survey also revealed that the growers preferred earlier maturing than the late varieties recommended to them. Thus, some of the findings indicated that varieties with the following characters were preferred:

(*a*) height of the plant should range between 5-7 feet to reduce both root and stem lodging.

(*c*) two ears per stand to those with one large ear,

(*c*) yellow grains, either flint or floury are wanted for *fresh maize on the cob* type for consumption as boiled or roasted maize.

(*d*) white floury maize varieties having high flour content per acre for such local dishes as *Ogi, Eko and Tuwo.*

COWPEA BREEDING

One hundred and fifteen indigenous cowpea varieties were grown under irrigation in the 1966/67 dry season at Moor Plantation, Ibadan at a spacing of one foot apart on three feet ridges.

Observations on the following characteristics were recorded:

(*i*) No. of days from seeding to flowering.

(*ii*) No. of days from first to last flower bud opening.

(*iii*) No. of days from first to last ripening pod.

(*iv*) No. of pods per plant and seeds per pod.

(*v*) Weight of 100 seeds.

(*vi*) Grain yield per acre.

(*vii*) Crude protein content.

Figures 1 to 9 give the graphic representation of each character. Fifty per cent of the 115 local cultivars flowered between 42 and 46 days (fig. 1) after seeding. There was a maximum difference of only seven days between the flowering of first and last variety and the varietal differences in the flowering dates were significant.

The difference in the duration of flowering between the shortest and longest (fig. 2) was found to be six days. This character determines the evenness or otherwise of the ripening of pods. It was observed that a short duration from first to last flower bud opening was directly related to even ripening of pods. This character is greatly affected by factors influencing flower bud abscission and pod settings, e.g. insect pests and weather. The Varieties differed significantly in this character.

The difference between the varieties with shortest and longest period for pod ripening was found (fig. 3) to be only six days. Some varieties seem to differ significantly in this character, which appears to be highly influenced by the prevailing weather conditions.

Local varieties varied significantly from others in their characters for the number of pods per plant, seeds per pod, weight of 100 seeds and the grain yield per acre (figs. 5, 6, 7 and 9). The highest and lowest grain yields per acre were approximately 400 and 2000 lbs per acre, most varieties had 14 to 18 pods per plant, 12 to 14 seeds per pod and exceeded 16 gms per 100 seeds in weight.

Although there were significant differences between some varieties, most of these contained about 25 per cent crude protein. A high crude protein content was found to be significantly associated with large seeds. The difference between the lowest and the highest crude protein content was only 6 per cent (fig. 8).

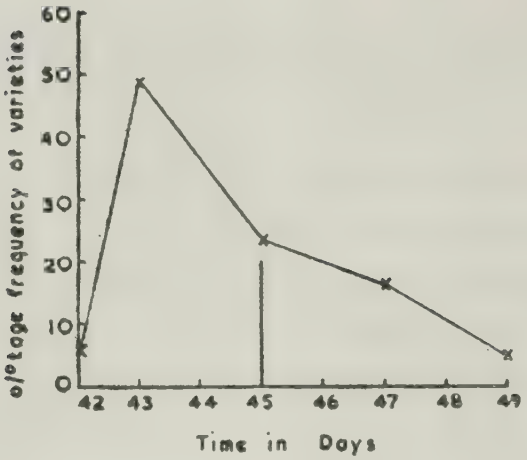

Fig.1 The distribution of cowpea varieties according to no. of days from seeding to flowering.
The mean = 45 and standard deviation = ± 2

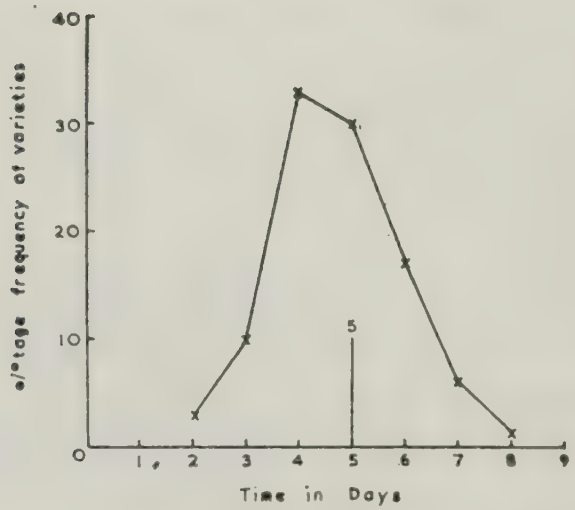

Fig. 2 The distribution of cowpea varieties according to the no. of days from the first to last flower bud opening.
The mean = 5 and standard deviation = ± 1

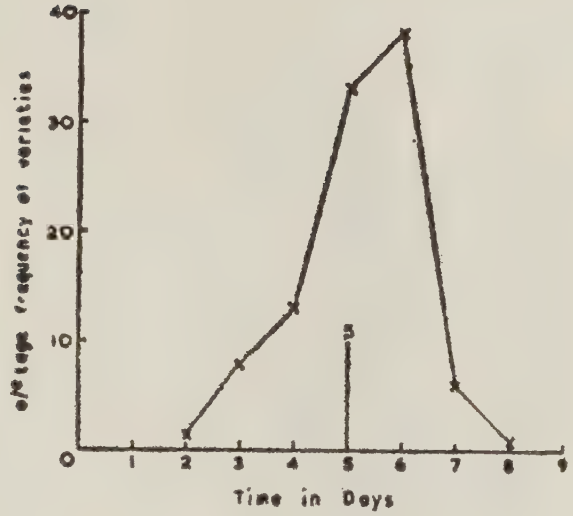

Fig. 3 The distribution of cowpea varieties according to the no. of days from the first to last ripening pod.
The mean = 5 and standard deviation = ± 1

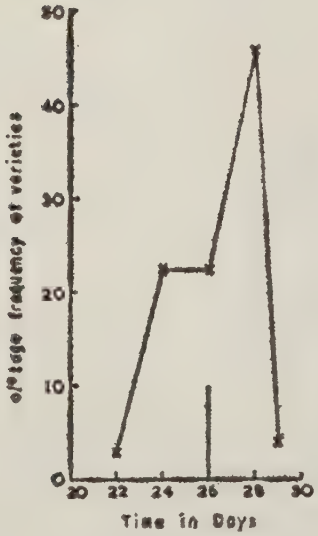

Fig. 4 The distribution of cowpea varieties according to the no. of days from flowering to ripening.
The mean = 26 and standard deviation = ± 2

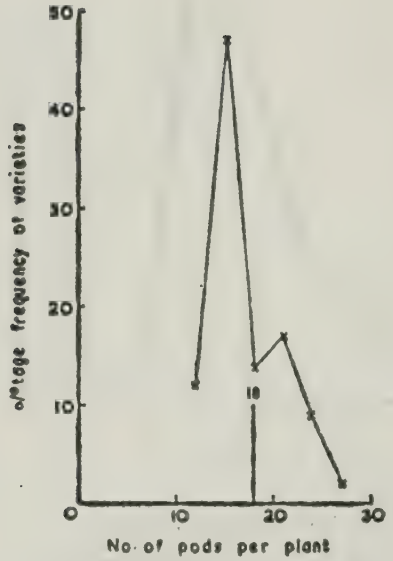

Fig.5 The distribution of cowpea varieties according to the no. of pods per plant
The mean = 18 and standard deviation = ± 3

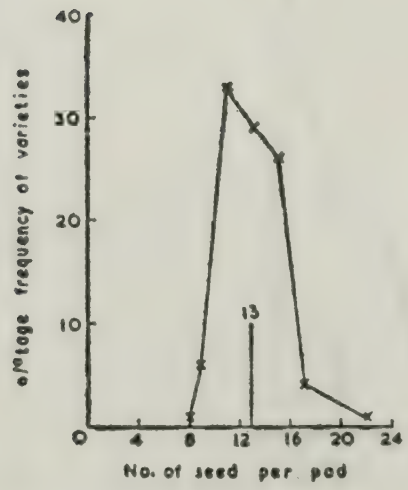

Fig 6 The distribution of cowpea varieties according to the no. of seeds per pod
The mean = 13 and standard deviation = ± 2

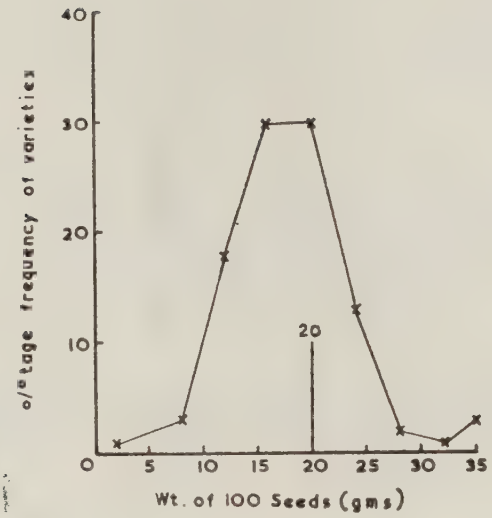

Fig.7 The distribution of cowpea varieties according to the weights of 100 seeds
The mean = 20gms and standard deviation = ± 4

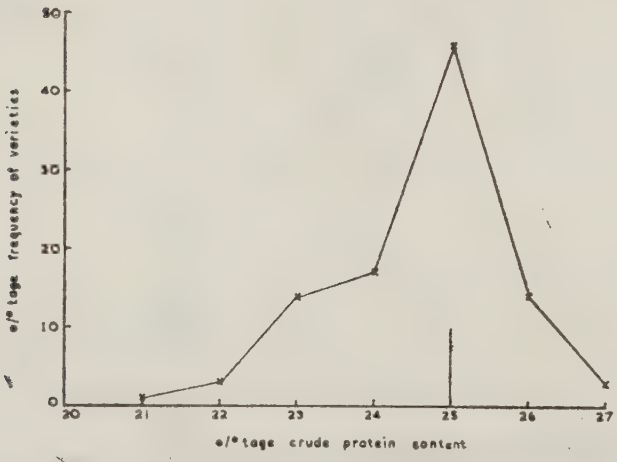

Fig. 8 The distribution of cowpea varieties according to the crude protein content
The mean = 25 and standard deviation = ± 1

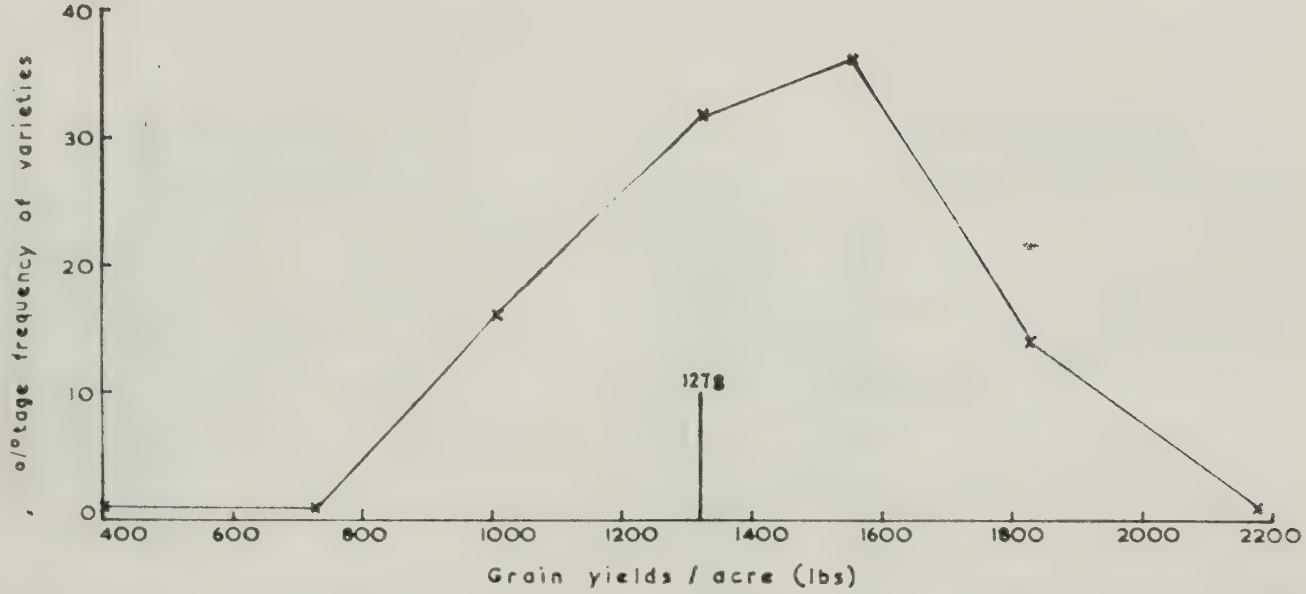

Fig. 9 The distribution of cowpea varieties according to the grain yields/acre (lbs)
The mean = 1278 and standard deviation = 274

Genetic Studies

The mode of genetic inheritance of photoperiodic response, maturity period, growth habit, and seed coat texture of cowpeas were studied during 1968/69. Statistical analysis of the number of days to flowering indicated highly significant difference between the hybrid and the late flowering parent while photoperiodic neutrality was dominant to sensitivity.

Maize Agronomy

Cost of hoe weeding in maize fields during the cropping season is caused by the fast rate of growth of enormous number of weeds. The use of selective weed-killers is becoming increasingly popular in other countries. The comparative effect of selective herbicides and hoe weeding on grain yields was studied in the late season of 1968/69 on maize planted on both ridges and flats.

Table 6 shows the mean grain yields per acre (lbs) of maize variety NS-1 obtained from a study involving method of cultivation and weeding at Moor Plantation.

Table 6: Mean Grain yields per acre (lbs) for the cultivation and Weeding methods on the maize variety NS-1, 1968.

Cultivation Method	*Weeding Methods*			
	Gramoxone	*Hoe*	*Simazine*	*Mean*
Flat	3360	2990	2560	2970
Ridge	2830	3120	2260	2730
Mean	3095	3055	2410	2850

Coefficient of Variation (%) = 14.8

Sources	S.E.	L.S.D. (5%)	L.S.D. (1%)
Cultivation Methods	213	N.S.	N.S.
Weeding Methods	232	360	437
Interaction	329	N.S.	N.S.

The foregoing data indicate a comparatively superior yield performance of maize planted on flats than those on ridge. No significant difference was obtained between post-emergence herbicide gramoxone and hoe-weeding. On the other hand, these two were very significantly superior to the pre-emergence herbicide simazine. The interaction between the two methods of weed control was not significant.

Legume Agronomy

Effect of Cover Crops on Soil Fertility

An experiment designed in 1966 to compare the effect of seven leguminous cover crop species on soil fertility as measured by maize grain yield per acre indicated that neither the cover crops nor the fertilizer treatments were effective and that there were no significant differences between the mean yields of NS-1 test crop. The control was natural regeneration of weed (Bare) while the cover crop species were *Calapogonium mucunoides, centrosema pubescens, Indigofera hirsuta, Pueraria phaseoloides, Mimosa invasa, Mucuna utilis* and *stylozanthes gracillis.*

The non-significant increase of 457.4 lbs per acre shelled grain of the plot receiving 60 lbs N and 40 lbs P_2O_5/acre over no-fertilizer plots showed that turning-in of the herbage cover crop should be followed by the addition of judicious quantities of fertilizers to boost the succeeding crops. Of the seven cover crop species used in the experiment, *Stylozanthes gracillis and Pueraria phaseoloides* appear to be the best in smothering weeds, good persistence and having the least nematode counts and minimised the incidence of root-lesion nematodes. The other four species had high populations of nematodes and which suggested that they were not fit to be used as cover crops in rotations.

Optimum time of planting Cowpeas

The experiment reported in the 1967-68 annual report was modified in 1968-69 to include three more varieties, namely: New Era, Igbira, and Mala and planting was done on two-weekly intervals. The results obtained in the modified experiment was similar to that of 1967/68. It was found that the best yield of cowpea grain in pounds per acre was obtained in the September and October planting, and the quality of seeds harvested from plantings at this period was very much superior to those obtained from late June and July plantings.

RICE AND ROOT CROPS DIVISION

Root Crop Agronomy

Time of Harvest—Cassava

The cassava varieties 53101, 44086, 60447 and 37065 were used in an experiment to determine the effect of sowing period on yield and starch content of the tubers. The trial was a randomised split plot design with the varieties as main plots and growing periods as sub-plots. The growing periods were 12, 15, 18, 21 and 24 months. The results obtained are shown in Table 7 on page 25.

Table 7: Time of harvesting in months × Variety: yield in lbs/plot and tons/acre

Time / *Varieties*	12	15	18	21	24	*Total*	*Mean*	*Tons/ acre*
60447	687	987	982	1080	946	4182	234.1***	15.8
53101	756	883	1087	1094	724	4544	277.2	15.3
37065	625	665	871	625	669	3455	172.8	11.7
44086	444	601	588	463	452	2548	172.4	8.6
Total	2512	3136	3528	3262	2791	15229	—	
Mean	157.0	196.0	220.5***	203.9	174.6	—	190.4	
Tons/acre	10.60	13.23	14.88	13.76	11.79	—	—	12.85

L.S.D. (p=0.05) = 29.5 lbs per plot/1.2 tons per acre
L.S.D. (p=0.01) = 35.5 lbs per plot/2.4 tons per acre
L.S.D. (p=0.001) = 57.8 lbs per plot/3.5 tons per acre.

The above results indicate a very highly significant difference in yield amongst varieties. Thus, varieties 60447 and 53101 were significantly superior in yield to variety 37065 (p= 0.01) and 44086 (p=0.001). There was, however, no significant difference in yield between varieties 60447 and 53101. Yield at 18 months was highly significantly superior to that at 12 months (p=0.001), at 24 months (p=0.01 and at 15 months (P.0.05).

An analysis of starch yield in relation to times of harvesting and the varieties is given in Table 8:

Table 8: Percentage starch yield in relation to time of harvesting.

Varieties / *Time in months*	53101	44086	60447	37065	*Total*	*Mean*
18	26.58	22.04	23.23	15.67	87.52	21.88
15	24.24	21.34	16.23	18.79	80.60	20.15
12	19.38	17.78	16.00	18.53	71.69	17.92NS
24	19.64	16.20	15.12	17.45	68.41	17.10
21	15.00	19.00	18.10	12.20	64.30	16.00
Total	104.84	96.36	88.68	82.64	372.52	
Mean	20.97	19.27	17.74	16.53		18.63

N.S.

The difference in yield of starch in relation to the harvesting time was found to be very significant. Highest yield of starch was obtained when harvesting was done at 18 months. It was also observed that the starch yield increased in the 12 months old crop to that of 18 months old and declined in the crop harvested after 15 months growth.

Time of Planting—Cassava

A trial was initiated in June 1967 to determine the effect of date of planting on the twelve months' yield of Cassava. A randomised split plot design was employed with the varieties 53101, 60444, 60447 and 60506 as main plots and planting time as sub-plots for planting time represented by the months of June, July, August, September and October. Harvesting was completed in October 1968.

Table 9 shows the yield of each variety at the different times of planting.

Table 9: Time of planting : yield of Varieties in lbs/plot and tons per acre.

Varieties / *Times in months*	53101	60444	60447	60506	*Total*	*Mean lb/plot*	*Tons/ acre*
June	775	789	844	716	3124	195.25	15.82
July	694	761	678	657	2790	174.37	14.12
August	306	484	328	297	1415	88.47	7.16
September	257	296	391	325	1269	79.31	6.42
October	212	78	209	181	680	42.50	3.44
Total	2244	2408	2450	2176	9278		
Mean lb/plot	112.2	120.4	122.4	108.8		115.97	
Tons/acre	9.07	9.75	9.92	8.81			9.39

N.S.

L.S.D. (p=0.05) = 18.12 lbs per plot = 1.47 tons per acre
L.S.D. (p=0.01) = 24.25 lbs per plot = 1.97 tons per acre
L.S.D. (p=0.001) = 31.85 lbs per plot = 2.59 tons per acre.

There were significant yield differences between planting times. Thus planting in June was significantly superior to July planting (p=0.05) and to August, September and October plantings (p=0.001), while July planting was significantly superior to August, September and October plantings (p=0.001).

Yam Agronomy: Fertilizer Trial

In an experiment with white yam variety Gwaguzu (Acquisition No. 107), using three levels each of N (0, 30 and 60 lbs N per acre) in the form of Ammonium sulphate, P—(0, 20, 40 lbs P_2O_2/acre) in the form of single superphosphate and K (0, 20, 40 lbs K_5O_5/acre) in the form of Potassium sulphate, interesting data were obtained. The effect of these elements on (*i*) yield of white yams, (*ii*) dry matter and starch contents of the tubers, and (*iii*) storage properties of the tubers were recorded. Planting was done in March, fertilizer was applied in July and harvesting was completed in December 1968. The results of the trial are shown in Table 10.

Table 10: Summary of Mean yields (Tons/acre)

Treatments	Yield
N_0	6.90
N_1	7.49
N_2	7.08
P_0	7.22
P_1	6.93
P_2	7.33
K_0	7.00
K_1	7.34
K_2	7.13

S.E. of treatment mean = ± 0.11 ton/acre
C.V. = 13.6%

Responses to nitrogen and potassium were insignificant, but appreciable yields of the order of 1120 lb and 670 lb tuber per acre were obtained with the first levels, respectively. Phosphorus depressed yield at the first level but gave slight increase in the second level. The lack of a significant response to any of the elements applied is attributable to their time of application, and July would appear rather late.

The results of the determination of the dry matter content and starch content of tubers are shown in Table 11.

Table 11. Dry matter and starch contents X in relation to fertilizers applied

Treatments		Dry matter content (per cent)	Starch (per cent)
N_0		30.4	18.9
N_1		33.0	19.6
N_2		32.8	17.4
P_0		31.5	18.9
P_1		32.3	19.3
P_2	N.S.	32.5	17.9
K_0		32.2	19.1
K_1		31.9	17.4
K_2		32.1	19.2
S.E. of treatment mean	$= \pm$	0.82	0.64
C.V.	$=$	13.3%	10.4%

No significant differences were obtained for dry matter content and starch content of the tubers due to the application of the nutrient elements. It would appear that starch content of the tubers decreased with higher levels of nitrogen and phosphorus, while responses to potassium were inconsistent.

Yam storage trials

After the harvest which took place in December, an experiment was set up to study the effect of the fertilizers in the foregoing trials on storage properties of yams. Loss of weight was determined at fortnightly intervals for five months after discarding the sprouts and rotten tubers on each occasion. There was significant weight loss ($p=0.05$) in tubers obtained with use of higher level of phosphorus than those at lower levels and without the element. No significant weight losses were recorded for nitrogen and potassium applied at any of the three levels of each of the nutrients.

CASSAVA BREEDING

At Moor Plantation, production of cassava hybrids was continued to explore the possibility of improving the yield and mosaic resistance. Crossing was carried out between high yielding variety 60444, and mosaic resistant interspecific hybrids 58198, 58212 and 58308 and also intercrossing was carried out amongst the latter three varieties. In addition, variety 58198 was also shelfed and crossed with variety 32031. Over 8000 hand pollinations were carried out during the period under review and over 7,000 viable seeds were collected from these for further planting in the nursery.

The Umudike substation where most of the root crop trials were sited in the past continued to remain cut off because of the current civil war. On the other hand, trials planted at Iyanomo, Mokwa and other sites had to be suspended due to very poor germination.

Yam Breeding

Selection of varieties suitable for different ecological zones was continued. Until a suitable method of inducing flowering in yams for breeding purposes is evolved, selection for high yield potential will continue to be based on improved agronomic qualities.

Yield trials were conducted at Moor Plantation, Iyanomo and Mokwa, with varieties of three species of white **(Dioscorea rotundata),** yellow **(D. cayenensis)** and water **(D. alata)** yams. At Moor Plantation, the yields of white yam varieties were as follows:

Variety	Yield in tons/acre
0107 (Gwaguzu)	6.54
0123	6.44
0122	5.67
0166	5.45

There was no significant difference in yield among these varieties. At Mokwa, varieties Awala and Ekunadu with 7.01 and 7.00 tons per acre respectively out-yielded Gwaguzu which produced 5.69 tons per acre. The differences are considered considerable but were not significantly different. At Iyanomo, the highest yielding variety was 0107 (Gwaguzu) with 3.59 tons per acre.

In the yellow yam trials, the varieties 401 and 351 were the highest yielders at Moor Plantation producing 4.19 and 4.00 tons per acre respectively. At Iyanomo, varieties 395 and 354 yielded 2.86 and 2.39 tons per acre respectively. In the water yam trials at Moor Plantation variety 680 significantly outyielded all others producing 8.7 tons/acre ($p=0.001$) and was resistant to Anthracnose disease to which all others were susceptible. At Iyanomo, variety 764, which was the highest yielder with 4.42 tons per acre, significantly outyielded ($p=0.05$) variety 680 which was the best, as reported above, under Ibadan conditions. At Mokwa, the variety Wura was the best with 2.97 tons per acre.

UPLAND RICE BREEDING—Upland rice breeding programme is directed towards producing a higher yielding replacement line than OS-6 and possessing characteristics such as (*i*) narrow leaves with short stiff straw, (*ii*) long grain, (*iii*) high resistance to blast and **Helminthosporium oryzae,** and (*iv*) having response to fertilizer. Twenty-six new introductions are currently being subjected to a comparative study against OS-6 in an observation plot.

BREEDING FOR BLAST RESISTANCE

Selection for long grain and upright plant habit has been made and the following progenies are retained for further studies: 55/4, 55/29, 56/215, 56/230 and 57/170.

A trial to compare the yield, **Helminthosporium** infection, growth habit and adaptiveness to upland conditions of these progenies with OS-6 which is the standard recommended upland variety, was carried out in 1968. Data recorded on some agronomic characters, disease and yield are shown in Table 12 on the basis of 500 plants per plot at planting time:

Table 12: Some agronomic, disease and paddy yields data of 5 progenies compared with OS-6 (1968)

Progeny No.	*Tiller count per stand*	*Plant height at flowering (CM)*	*Lodging (%)*	*Duration (days)*	*Helminthosporium infection (score)*	*Yield per plot (lbs)*	*Yield per acre (lbs)*
55/4	13	109	75	133	1	12.70	1106
55/29	13	106	75	148	0	12.22	1065
OS-6	10	113	75	118	0	10.74	936
57/170	10	117	75	119	0	8.26	720
56/215	10	120	75	124	1	7.70	671
56/230	9	111	50	124	1	5.42	472
C.V.(%)	—	6.57	—	—	—	33.90	—
LSD (5%)	—	9.23	—	—	—	4.45	—
LSD (1%)	—	12.43	—	—	—	—	—

The above results show that with regard to yields no significant differences were obtained from progenies 55/4, 55/29, 55/170 and OS-6, but the first two were statistically superior to progenies 56/215 and 56/230 ($p=0.05$). Highest yield of 1106 lbs/acre was obtained from progeny 55/4 closely followed by 55/29 with 1065 lbs/acre.

National Zonal Yield trials

National Zonal trials in the Southern States, between 1963 and 1965 led to the replacement of previously recommended variety, Agbede 16/56, by OS-6 in the Western, Midwestern and Eastern States. Subsequent trials in 1964/65 at Jema'a led to the recommendation of OS-6 as the upland variety in Southern Zaria Province.

In 1968, a series of trials was repeated at nine sites in the North and one in the savannah of the West. These were intended to produce a recommended upland rice variety for cultivation in the derived savannah areas of Nigeria.

A joint analysis of the yield data from nine centres are given below in Table 13. Excluded was the data from the tenth centre (Dogongari) which were extremely poor:

Table 13: Yield of 6 varieties of upland Rice at 9 sites in 1968 (Yields in lbs/acre)

Variety	*Sites*									*Total*	*Mean*
	Wushi-shi	*Tunfa-fiya*	*Pank-shin*	*Kiri*	*Ilora*	*Denga*	*Jema'a*	*Ajase*	*Yola*		
E.425	4,773	2,683	2,258	1,526	1,625	1,969	1,574	929	867	18,104	2,012
R66	3,973	3,612	2,193	1,715	1,496	1,914	1,375	714	635	17,627	1,959
OS.6	4,259	3,291	2,193	2,369	1,858	960	1,250	722	619	17,521	1,947
OS.4	4,928	3,096	1,924	1,543	1,574	1,205	1,426	712	617	17,025	1,892
Agbede	3,947	3,186	2,053	1,324	1,754	1,548	1,366	578	715	16,471	1,830
Bikom	3,999	1,837	2,000	1,634	1,575	1,798	1,267	712	666	15,488	1,721
Total	25,879	17,705	12,612	10,111	9,882	9,394	8,158	4,367	4,119	102,236	
Mean	4,313	2,951	2,104	1,685	1,647	1,566	1,360	728	687		
F.M.S.	160.63	210.46	599.58	138.73	58.41	127.99	28.78	24.91	257.00		
C.V.	11.5	19.2	45.8	27.7	21.3	28.5	15.5	27.0	98.8		

A comparison of yields obtained at various stations show that upland rice trial was best at Wushishi and it was significantly better than all other stations ($p=0.01$). The error mean square was heterogeneous.

UPLAND RICE AGRONOMY

Fertilizer and Spacing trials

The OS-6 variety was introduced in the south essentially on the basis of its responsiveness to fertilizer application. In order to determine its ability to respond to fertilizers, experiments were conducted at Moor Plantation and replicated at 6 centres to compare application of 3 levels of ammonium sulphate at 0, 1 and 2 cwt/acre, 2 levels of superphosphate at 0 and 1 cwt/acre and 2 spacings of 12 × 12 inches and 12 × 6 inches.

Significant yield increases due to application of 1 cwt Ammonium sulphate per acre was obtained at Moor Plantation, Wasimi, Irrua and Jema'a. On the other hand, at Ikenne and Irrua the yields were significantly decreased by the application of 2 cwt/acre of Ammonium sulphate.

Application of superphosphate depressed the yields at Moor Plantation and Ilele by 2.7% and 13.2% respectively. There were no significant responses to the applications of ammonium sulphate and superphosphate at Ado-Ekiti.

At all centres, the highest yields were obtained from the 12 inches × 12 inches spacing. At Jema'a the application of ammonium sulphate at 1 cwt/acre with plants spaced at 12 inches × 12 inches was the best combination and it was significantly superior to all other interactions of ammonium sulphate and spacing.

Time of application of Nitrogen

In 1968, investigation was continued at Moor Plantation to determine the optimum time of application of ammonium sulphate to OS-6 variety of upland rice. From the results, it appeared that nitrogen applied at the following three stages during the growth of rice plants gave the best yield:

One-third at planting
One-third at 30 days after germination
One-third at 60 days after germination (i.e. 30 days before flowering)

Herbicide Trial

The effect of stam F-34, a post-emergent selective herbicide (3,4, dichloropropionanilide), on upland rice was studied with certain modifications in 1968 at Moor Plantation. The effect of three methods of application of the herbicide, namely, (*i*) single application of spraying with 2 lbs, 3 lbs and 4 lbs active ingredient per acre, (*ii*) spraying at split application with 4 lbs, 6 lbs and 8 lbs a.i. per acre, and (*iii*) No spraying (control), on weed growth and yield of rice were compared. All the plots were split for hand weeding and No-Hand weeding sub-treatments.

Stam F-34 was successful in completely killing the following species of weeds: Graminae **Papilionaceae, Cyperaceae, Compositae, Convolvulaceae, Euphorbiaceae**, on the first spraying. The effect was observed 10 days later, following the spraying of the herbicide one month after seeding. Weed population was significantly lower in plots sprayed with 4 lbs a.i. per acre of Stam F-34 irrespective of the dosage employed.

Table 14 shows the economics of the application of Stam F-34 on the weed in upland rice crop.

Table 14: Economics of herbicide (Stam F-34) application on upland rice weeds, 1968

	Total Cost in shillings/acre				Total Gross return in shillings/acre			
Treatment	*Hand weeding*	*Herbicide*	*Spraying*	*Total*	*Yield/ acre (lbs)*	*Price lb. (pence)*	*Gross return (shillings)*	*Net return shillings*
1A	—	—	—	—	42.00	2.4	8.40	8.40
1B	170.25	—	—	170.25	2502.00	2.4	500.40	330.15
2A	—	66.66	18.00	84.66	2073.00	2.4	414.58	329.92
2B	40.50	66.66	18.00	184.66	2569.20	2.4	513.83	388.67
3A	—	100.00	18.00	118.00	2506.20	2.4	501.23	388.23
3B	17.25	100.00	18.00	135.25	2403.00	2.4	430.60	345.35
4A	—	133.32	18.00	151.32	2466.00	2.4	493.20	341.88
4B	21.00	133.32	18.00	172.32	2481.00	2.4	496.20	323.88
5A	—	133.32	36.00	144.32	2241.00	2.4	448.20	278.88
5B	34.75	133.32	36.00	201.07	2398.20	2.4	429.64	270.57
6A	—	200.00	36.00	286.00	2245.00	2.4	453.00	217.00
6B	33.12	200.00	36.00	267.12	2518.20	2.4	503.64	236.52
7A	—	266.66	36.00	332.66	2583.00	2.4	516.60	312.94
7B	15.25	266.66	36.00	338.44	2865.00	2.4	573.00	254.56

N.B. 1. A= unweeded sub-plots, B=Hand weeded sub-plots

2. (*i*) Treatment 1=control (unsprayed)
   (*ii*) Treatment 2, 3 and 4=2, 3, and 4 lbs respectively of a.i./acre of Stam F-34 applied as a single dose.
   (*iii*) Treatment 5, 6 and 7=4, 6 and 8 lbs a.i. per acre of Stam F-34 in split application.

3. An average of three persons have been taken for herbicide application per acre.

4. Average labour wages are calculated at 6/- (six shillings) per working day of 8 hours.
5. Hand weeding charges calculated on the basis of actual time used for weeding.

The results indicate that although a maximum gross return of 573 shillings per acre was obtained with the application of 8 lbs in two split applications and one hand weeding, this was not, however, reflected in maximum net returns owing to the high cost of 8 lbs of stam F-34. The highest net returns of 388.67 and 383.23 shillings per acre were obtained by the application of 2 lbs a.i./acre with one hand weeding and at 3 lbs a.i./acre without hand weeding respectively.

SOIL FERTILITY AND CHEMISTRY DIVISION

General

Work in this Division was mainly directed towards rendering a wide range of analytical services on the one hand and the continuation of long term experiment on the maintenance of soil fertility on the other. At the same time several new problems of basic research in crop nutrition were also undertaken. Efforts were continued toward the completion of the preliminary calibration of the two Hilger Spectrographs for the determination of trace elements in soil and plant materials. The lack of suitably qualified staff continued to slow down the progress of work in this field.

The Chemistry Laboratory at Rice Research Station, Badeggi, was strengthened by the posting of a Research Officer to continue the work on soil/plant nutrition of swamp rice, since the departure of the Japanese Soil Chemist, Mr Y. Honjo, during the year. At the same time the scope and range of analysis undertaken by the laboratory was also enhanced in respect of soils, rice materials and irrigation water, which were vigorously pursued.

Conventional Analysis: Large number of soil samples related to Divisional research projects as well as from other sections of the Department including the out-stations, were analysed primarily for NPK on a routine basis. Analysis of more specific nature like Cation Exchange Capacity, soil reaction, Fe^{++}, Al^{++}, available phosphate, Ca^{++}, Mg^{++} were also taken up during the year. Besides, a substantial amount of time was devoted to rendering analytical services to outside agencies like the Universities, Institutes, State Ministries, and Commercial firms dealing with agricultural commodities like Sugar cane, Tobacco, etc.

Plant analysis generally consisted of the determination of starch, moisture and hydrogen cyanide content of cassava tubers, received from the Rice and Root Crops Division as well as from outside bodies. Maize leaf analysis constituted an important aspect of specific projects using this crop as a test material in crop nutrition studies.

Spectrographic Analysis

Work on the calibration of the Hilger spectrographs were continued. Simultaneously, steps were taken to purify the required chemicals as well as to preconcentrate the materials to be analysed. Two distinct methods of analysis were adapted for routine analytical work involving the spectrographs.

Farmer's Method: Suitably concentrated Trace Element mixtures were prepared for the determination of Sr, Ba, Cu, Mn and Fe in plant material according to Farmer's method. This method utilizes the large Hilger Spectrograph with Farmer's 1:2 Carton electrode for arcing in the wavelength range 2900-5500$^{\circ}_{A}$.

Variable Internal Standard Method: A stock of standard mixture containing 1 ppm. standard of each of 34 elements was carefully prepared, containing, in addition, 5% Fe_2O_3 which is used as a correction factor in the sample. This method is employed for the accurate determination of any of the 34 elements in soil samples by the large Hilger Spectrograph using 1:1 carbon electrode in the wavelength ranges of 2480-3500$^{\circ}_{A}$ and 3000-6200$^{\circ}_{A}$.

Chemical Concentration: In view of the extremely low quantities of the elements present in the parent material used in the analysis of micro-nutrients, it is essential to enhance the quantities several fold in the soil and plant material examined. Preliminary work showed that approximate concentration of an element 500-fold in 40 mg. of sample ash is adequate to meet the requirements of the spectrographic analysis.

A mixture of 8-hydroxyquinoline, tannic acid and thioanilide gives complete recovery of Co, Ni, Mo, Cr, V, Be, Ge, Sn, Ti, Zn, Cu, Ca, Tl and Ag. Several samples of different soil types were extracted separately with N-NH_4Ac, ED-TA and Glacial Acetic Acid and subsequently concentrated successfully.

Trace-element status of Niger-Kaduna-Gboko flood plains

An attempt was made during the year to determine the micro-nutrient status of rice growing areas of the Niger-Kaduna-Gboko flood plains in order to supplement earlier information on the major nutrients (cf, Annual Report, 1967-68). Profile soil samples were taken at Badeggi at three profile depths of 0-5″, 5-10″ and 10-30″ from each of the 12 recognised soil series, namely, Kulfo, Santigi, Tsantsaga, Kaduna, Musa, Indaloke, Agaie, Mawogi, Badeggi, Yanpere, Sawazuru and Edozhigi.

The following trace elements were identified by correlating the intensity of the observed lines in the wavelengths characteristic of the specific elements:

Trace-elements		**Wave-lengths at which identified (A)**
Vanadium	V	4379.24 and 3185.40
Cobalt	Co	3453.51
Nickel	Ni	3453.51
Zinc	Zn	3414.77
Titanium	Ti	3989.80
Copper	Cu	3273.96
Tin	Su	3175.02 and 2839.99
Molybdenum	Mo	3170.35
Boron	B	2497.70
Manganese	Mu	4034.50
Chromium	Cr	4254.30

Following these preliminary qualitative data, it will now be possible to determine the quantitative distribution of the agriculturally important trace-elements in the profiles of the different soil types of Niger-Kaduna-Gboko flood plains.

Fe and Mn contents in rice leaf and straw

Representative leaf and straw samples were taken from each of the 10 experimental plots which were reported to be affected by an incidence of blight or possibly other pathological symptoms. These samples were spectrographically analysed for Fe and Mn contents by the large Hilger Spectrograph, E478, using Farmer's method with Cr lines 3593.5$^{\circ}_{A}$ and 4254.4$^{\circ}_{A}$ for Fe and Mn respectively. The average Fe/Mn (leaf) and Fe/Mn (straw) was found to be 0.40 and 1.28 respectively. The mean Fe/Mn ratio of the aerial part (l+s) thus amounted to 0.84. It may be noted that Fe/Mn ratio of a wide range of crop is considered to lie between 1.5 and 2.5 for normal growth. Values lower than the former are indicative of Mn toxicity due to excess of this element while the latter indicates Mn- deficiency (Stiles, 1946) due to higher concentration of Fe. It could be deduced from this observation that the crop in the experimental plots might have been affected by apparent Mn toxicity.

Cation Exchange Capacity: C.E.C. of soil is a fundamental parameter in determining the agricultural potentiality of a given piece of land. It is defined as the maximum number of cations a soil can absorb. It is a measure of both mineral particles (clay fraction) and the organic components (humic fraction) of soil and is expressed in milli-equivalents per 100 gms of dry soil. A knowledge of this factor usually offers a good first approximation of the fertility status of soil.

An experiment was commenced with the Catenary Association of soils, found at Moor plantation, to determine the C.E.C. of the representative soil series of Iwo Association, namely: (*i*) Ibadan, (*ii*) Iwo, (*iii*) Apomu and Motako, (*iv*) Iregun. The maximum and minimum values of C.E.C., found in each of these soils, is given in Table 15 below.

Table 15: Cation Exchange Capacity of different Soil Series at Moor Plantation (m.e. per 100 gm dry soil)

Soil Series	Maximum	Minimum	Average
Iwo	2.98	0.30	1.47
Ibadan	1.69	0.60	1.10
Egbeda	5.95	3.38	4.59
Apomu	5.60	2.30	3.93
Iregun	4.90	2.00	3.35
Motako	3.30	1.20	2.12

The above data clearly indicates the greater ability of the soils of Egbeda series to supply plant nutrients and consequently, its being the most fertile of all the soil series on Moor Plantation. Apomu and Iregun series seem to follow the Egbeda series in the order of their respective fertility levels and would be expected to give greater response to the

application of fertilizers. Soils of Iwo and Ibadan series, on the other hand, tend to be sandy and porous allowing free passage of water and air. The low C.E.C. in these soils is suggestive of poor moisture and nutrient retention capacities. Consequently, these soils are less suitable for cropping. Motako series could be described as medium quality in terms of C.E.C. and is comparatively poorly drained—generally occupying a gently sloping level invariably close to a stream.

NPK trials on Starch and Dry Matter Content of Yam tubers

Yam tuber samples from a trial conducted in collaboration with Rice and Root Crops Division involving 3 levels each of N, P and K, were analysed for Dry Matter and Starch content to see the effect, if any, of fertilizer application on these parameters. As reported under the Rice and Root Crops Division, the starch and dry matter content were not significantly different in the tubers receiving different levels of the fertilizers. There were also no significant interaction between the parameters and the different fertilizers.

Residual Effect of applied phosphates on Maize

The trial on yield response of a maize crop, to the residual amounts of five levels of phosphates applied in 1967, was continued at Moor Plantation and replicated at Mokwa in the derived savannah vegetation zone. Beside the initial application respectively of 0, 30, 60, 90 and 120 lb P_2O_5 per acre in 1967-68, all the experimental plots were given a basal dressing of 40 lbs per acre of each of N and K respectively in 1968. The yield data from both sites are given in Table 16 below:

Table 16: Yield data of Maize trials, 1968

Treatments	*Mean yield in lb/acre*	
	Ibadan	*Mokwa*
Control	2743	3028
30 lb. P_2O_5/acre	2672	3388
60 lb. P_2O_5/acre	2767	3448
90 lb. P_2O_5/acre	2809	3109
120 lb. P_2O_5/acre	2628	3237
S.E. per acre 27.83		151.25
C.V. 16.22		13.77
L.S.D. (p=0.05) 265		442.86

There were no significant yield differences due to residual effect of phosphates applied in 1967-68. The result suggests that there might have been sufficient incipient available phosphate already present in the soils at the two sites. The decrease in yield at Mokwa for

90 and 120 lb P_2O_5 per acre and at Ibadan for 120 lb P_2O_5 per acre might have arisen from the apparent high level of available phosphate which could adversely affect the uptake of other nutrients, especially N and K, by reason of ionic antagonism.

Phosphate placement trials on Maize

An experiment to study the effect of method, rate and time of phosphorus application on the growth, chemical composition and yield of maize was carried out at two sites in the Western State, namely: Ikenne and Shaki.

The details of treatments were:

Rate:		0, 20 and 40 lb P_2O_5 per acre.
Time of application:		0, 4 and 6 weeks respectively after planting.
Method of Application:	(*i*)	Applied broadcast:
		(*a*) before ridging
		(*b*) before planting
	(*ii*)	Applied below seed at planting
	(*iii*)	Applied by localized placement
	(*iv*)	Applied banded on both sides.

The data obtained so far from Shaki indicate that there were no significant differences among the methods of application, namely: (*i*) broadcasting, (*ii*) localized placement, and (*iii*) banding on both sides. Effects of time of application namely, 0, 4 and 6 weeks after planting, differed significantly between themselves at 1% level.

Preliminary results of the trial at Ikenne site, indicate similar trends to those found at Shaki as reported above.

Swamp rice trials—Badeggi

The problems of uptake and assimilation of nitrogen in rice soil/plant has been the primary interest of the Chemistry Section at the Rice Research Station, Badeggi. The major studies undertaken have been:

I. Assimilation of nitrogen by rice in relation to grain and straw yield

(*i*) **Methods of nitrogen application**

An experiment, started in 1966, was continued in 1968 both in the growth tanks as well as in the rice fields on the fadama. A basal dressing of $1\frac{1}{2}$ cwt. per acre of superphosphate was applied. The methods of nitrogen application (2 cwt. per acre of Ammonium sulphate used for the tanks were as follows:

(*a*) Broadcast and mixed 4″ deep into the soil by native stumping hoe just before flooding.

(*b*) Broadcast and mixed with soil by rake soon after flooding but before transplanting.

(*c*) Broadcast and mixed with the soil by hand 14 days after transplanting **(recommended normal practice)**

(*d*) No nitrogen application (Control).

For the field trial phosphate was applied in the same manner as for the tanks. Ammonium sulphate was, however, applied 14 days after transplanting in each case as follows:

(*a*) Surface broadcast, (recommended practice)

(*b*) Placement (2″) by Japanese Rotary weeder

(*c*) Placement (2-4″) by native stumping hoe

(*d*) Placement (6″) by pellets.

(*e*) No nitrogen (control)

Surface water, soil and plants and also drainage water (in the case of tanks) were sampled and analysed at regular intervals. The results obtained so far have clearly demonstrated the loss of 20 to 50% of applied nitrogen, primarily as run off, in the case of the recommended practice of general flushing and irrigation of the fields 3 days after N-application. Considerable lower losses were recorded (0 to 2%) where flushing was carried out 10 days after N-application. On the other hand sub-placement of N-application resulted in significantly higher ($P=0.05$) paddy yield, higher dry matter production, higher N-content in the plant and higher recovery of applied N- in plant and soil.

II. Effect of Varietal difference on nutritional requirement of rice

An experiment started in 1965, in collaboration with the Agronomy section, was continued in 1968 to study the efficiency of utilization of N, P and K with three varieties, namely, IR-8, SML 140/5 and SML 140/10 compared with Mas 2401 as standard variety. The rice varieties were tested to determine their response to the application of N at 0-6 cwt per acre of Ammonium sulphate. A split plot design was used with fertilizer treatments as main plot and varieties as sub-plot. N-application was in split doses consisting of (*a*) first half at tillering and (*b*) remaining half at ear initiation stage.

Results obtained so far indicate that the coefficient of variation was too high (30%) to demonstrate significant nitrogen content in grain and straw due to increased addition of fertilizer N. There was also no carry-over of fertilizer N from the added nitrogen.

III. Irrigation Water Analysis

An experiment, started initially in 1966 at Badeggi, was continued in 1968 for the study of nutrient contents of the irrigation water used for rice cultivation in the Niger Province. Representative samples were collected regularly at monthly intervals from 15 sites, namely: Rice Research Station—Fadama (7 sites), Luguma (2 sites), Kupanko (2 sites) and Edozhigi (4 sites) from places of rapid flow of water at about 10 cm below the surface. The samples were analysed for NH_4-N, NO_3-N, P,K+, Ca,++ Na+ Mg and pH.

Data collected so far indicate appreciable variation in the nutrient contents of the irrigation water sources. The highest quality was found at Fadama and the lowest at Edozhigi. The irrigation water from all the sources were rich in K+, low in Na+, Ca++

and Mg^{++} but particularly low in N and P, and does not meet the nutrient requirements of the growing crop for these two elements.

The pH of all the soil samples were generally slightly alkaline in nature.

Considerable seasonal variation was observed which markedly influenced the nutritional quality of the waters. Thus, the highest nutrient contents was obtained at the commencement of the rains (March-May) which progressively decline as the rains settled down. This may be attributed to the dillution effect of the rains as the season progressed. There has been no significant annual fluctuation in the nutrient composition. The results are not conclusive.

Long-Term Soil Fertility Experiments

The experiment, comparing three fundamentally different farming systems, namely, (*a*) continuous cropping, (F_o); (*b*) four years' cropping alternating with four years' grass fallow (F_1) and (*c*) four years' cropping alternating with four years' (F_2) grass ley was continued in 1968. Sub-treatments used in this multifactorial confounded trial include annual application of 4 levels of a nitrogenous fertilizer at 0, 30, 60 and 90 (lbN/acre), biennial application of 2 levels of a phosphatic fertilizer at 0, 40 lb P_2O_5/acre and of 2 levels of a potassic fertilizer at 0, 40 lb K_2O/acre in combination with all other treatments. The grass species used for fallow and ley is **Pennisetum purpureum,** while the crops are Cassava (variety 53101) and Maize (variety Eafro 231).

Although detailed statistical analysis has not been completed preliminary data based on soil analysis, indicate the following broad generalizations based on nutrient build up or loss under different farming systems vis-a-vis artificial fertilizers and the super-imposed compost application:

(*i*) Compost addition has resulted in the increase in pH over a period of one year in the order of $F0 > F_1 > F_2$ whereas with fertilizers alone there has been a slight decrease in pH of the soil.

(*ii*) Compost treated plots have shown the greatest increases of pH, organic carbon, total nitrogen, and available phosphate under fallow, ley, and continuous cropping system respectively.

ENTOMOLOGY DIVISION

Yam Pests

Yam beetle population

Larval population in the breeding areas at Agenebode, Midwestern State, was studied by examining 18 × 18 × 18 inch soil samples. The population was classified according to different stages of growth, namely, eggs, larvae, pupae and adults and recorded as shown in Table 18 below.

Table 18: Population of different stages of yam beetles at Agenebode 1967-68

Month		No. of samples taken	Larval	Instars		Adults			Eggs
			I	II	III	Pupae	0	0	
April	1–15	55	—	49	117	—	—	—	—
	16–30	68	1	35	207	—	—	—	—
May	1–15	61	—	6	142	10	—	—	—
	16–31	80	—	3	200	70	26	27	—
June	1–15	69	—	—	141	97	22	29	—
	16–30	113	—	—	11	36	46	24	—
July	1–15	228	—	—	—	2	38	26	—
	16–31	273	—	—	—	—	42	46	—
Aug.	1–15	198	—	—	—	—	53	78	—
	16–31	164	—	—	—	—	49	46	—
Sept.	1–15	113	—	—	—	—	33	42	—
	16–30	134	—	—	—	—	22	31	—
Oct.	1–15	142	—	—	—	—	6	25	—
	16–31	179	—	—	—	—	3	14	—
Nov.	1–15	64	—	—	—	—	16	23	—
	16–30	60	—	—	—	—	18	24	84
Dec.	1–15	71	44	—	—	—	39	16	125
	16–31	60	91	6	—	—	20	9	72
Jan.	1–15	84	157	17	—	—	6	—	16
	16–31	80	125	80	27	—	—	—	—
Feb.	1–14	67	92	121	27	—	—	—	—
	15–28	52	13	70	73	—	—	—	—
Mar.	1–15	75	19	76	86	—	—	—	—
	16–31	80	—	71	143	—	—	—	—

Migration

In 1967, the first adult was collected on May 20 and the first flight or feeding migration occurred on May 29. No definite flight was noticed at Agenebode and only small number of beetles were trapped in the light trap. The adult population of beetles as in Table 18 above represents the yam fields which were continually observed from May to October.

Oviposition

Oviposition in Agenebode lasted from November 18 to January 9. These observations compare favourably with those obtained in the laboratory at Ibadan.

Pests of sweet Potatoes

The history and biology of sweet potato weevil **Cylas puncticolis** was studied. Eggs were found laid singly in tubers or in the lower part of stems. In the laboratory, hatching took place in 3-4 days while larval period and pupal life lasted from 7-11 days and 3-4 days respectively at a temperature range of 76-81°F. Four to five generations of this pest occurred during the cropping season.

Insecticidal Control of Cylas puncticolis

Three insecticides namely Aldrin dust, BHC dust and Toxaphene granules were applied at three rates of 0, 1 and 2 lbs per acre active ingredient at the time of planting or at the time of tuber formation or at one month before harvest and were compared with an untreated check. Table 19 gives a two-way table of the weight of tubers damaged when the insecticides were applied at different rates:

Table 19: Weight of Tubers damaged (lh/acre)

Rates (*lb/acre*) *a.i.*	*Insecticides*				
	T	*A*	*B*	*Total*	*Mean*
0	1285.63	1085.98	1067.83	3439.44	1146.48
1	768.35	747.18	326.70	1842.23	614.08
2	1134.38	589.88	359.98	2084.24	694.75
Total	3188.36	2423.04	1754.51	7365.91	2455.30
Mean	1062.79	807.68	584.84	2455.31	818.43

L.S.D. 5% for insecticide = 19.90 T = Toxaphene
„ 5% for Dose = 20.00 A = Aldrin
B = BHC

There were no significant differences in the weight of clean tubers produced from the untreated and treated plots. However, there were significant differences in the weight of tubers damaged by sweet potato weevil in the various treatments.

BHC dust applied at the rate of 1 lb/acre at the time of planting and at 60 days later (tuber formation stage) gave the most effective control. Damage due to the weevil was reduced from 10.8% in the untreated to 5.7% in the BHC-treated plots.

Pests of Citrus

Work on citrus pests of Western Nigeria continued with special emphasis on scale insects (Coceoidea).

The population of most of the scale insects of sweet orange **Citrus sinensis** (L), studied during 1968, namely, **Lepidosaphes beckii. L. gloverii, Parlatoria pergandii, Unaspis citri** and **Coccus hesperidum,** at Moor Plantation, increased from a low level in the early part of the rainy season in the months of April/May attaining the annual peak in June. Thereafter, the population steadily decline and remained at a relatively low level.

The general decline could be ascribed to the incidence of two entomogenous funge. **Aschersonia sp.** and **Sphaerotille sp.** Also the parasite **Aspidiolipgagus** sp. was very active during this period and attacked both the male and female of **L. beckii. L. gloverii** and **U. citri** in particular causing a wide-spread incidence of emergence holes on the scale covering. During the period October-February, which were relatively the dry months of the year, the scale insect population declined, reaching the lowest levels in December-January. The early instars of scale insects particularly suffered heavy mortality rate at this time due, primarily, to high temperature and low afternoon humidity.

The incidence of **C. hesperidum** on citrus trees, was not governed apparently by seasonal climatic fluctuations but depended rather more on whether or not they were being attended by ants of the common species, **crematogaster sp.** independent of the season.

Locust Control

During 1968, there was an invasion of the desert locust **Schistecerca gregaria** Forsk, into the country. Flying swarms were first noticed on 23rd October in Askira areas of Bornu Province in the North-Eastern State. They finally moved across into North-Western State where they were last seen in December.

The swarm was comparatively harmless since they were not observed feeding, thereby, causing little or no damage to cultivated crops. They were sprayed with Lindane 20% (Gammalin 20) using CP 40 sprayers which proved satisfactory for low level spraying only.

Pests of Cowpea

Cowpea variety *Westbred* was grown both in the early and late seasons in a trial to compare the effectiveness of a number of insecticides, namely, Dieldrin, Carbicon, Novacron, Nogos, Thiodan, Thiocron, Didigram, Sumithion and Diazinon, on the basis of damaged flowers and pods as well as increase in yield. Insecticidal treatments were compared with an unsprayed control.

The insecticides were applied in both the seasons by spraying at the rate of 1 lb/acre (a.i.) from 4th-8th week after germination. Some plots received 4 sprays (4th-7th or 5th-8th week) while others received 3 sprays (5th-7th or 6th-8th week). The yield data following the application of insecticidal sprays is shown in Table 20:

Table 20: Effect of Spraying Cowpea with different insecticides on damage to flower and pods and on yield

	Early Crop			Late Crop		
Insecticides	% *Flower damage*	% *Pod damage*	*Mean yield (lb/acre)*	% *Flower damage*	% *Pod damage*	*Mean yield (lb/acre)*
Dieldrin	9.0	10.3	438.32	9.0	6.9	705.43
Didigam	18.9	19.1	304.92	16.5	8.2	550.55
Sumithion	21.5	22.19	457.38	16.3	8.5	705.43
Diazinon	28.75	20.9	392.04	17.7	11.9	721.16
Carbicron	31.25	26.3	387.52	21.3	10.3	711.48
Nuvacron	20.21	14.1	459.15	7.3	4.7	828.85
Nogos	28.75	25.6	349.39	19.0	22.9	532.40
Thiodan	12.13	10.6	402.02	4.2	4.1	783.83
Thiocron	38.95	50.0	245.93	25.2	32.2	606.21
Control	39.58	40.6	263.18	24.4	26.9	579.59
L.S.D. 5%	—	—	43.56	—	—	123.18

Spraying till the 8th week, irrespective of whether there were 3 or 4 sprays, gave higher yields, although not significantly enough, than where spraying ended earlier.

Both in early and late crops, nuvacron gave the highest yields of 459.15 lb/acre and 828.85 lb/acre respectively. Most of the insecticides gave higher yield than the control. The yields of control plots was higher than those treated with didigam and nogos in the early season while control plots yielded higher than those sprayed with thiocron in the late season. The higher yield in the late season was due only partly to the low rate of attack on flowers and pods. The climate during late season is more favourable for the production of cowpea largely due to a more balanced moisture regime generally found.

Insecticidal effect on growth phases of Cowpea

In another trial, the four different phases of growth of cowpea, namely vegetative (*A*) macroscopic flower-bud, (*B*) flower-opening, (*C*) pod maturation and ripening and (*D*) phases were used for spraying either singly or in combination with other phases and compared with an unsprayed control. The phases ABCD were sprayed from 1st week after germination until harvest, phases B and C were regarded as similar and the same phase

extended. Dieldrin at the rate of 1 lb/acre (a.i.) was sprayed at weekly interval on cowpea variety *Westbred*. The results of the late season indicate that by spraying phases BCD effective production is afforded. The yield data is presented in Table 21.

Table 21: Effect of Spraying at different phases of Cowpea on flower, pod damage and yield

Phase	*No. of Spray*	*% flower damage*	*% Pod damage*	*Yield (lb/acre)*	
O (control)	Nil	38.3	34.7	519.70	c.
A	3	32.9	30.0	570.52	c.
BC	3	15.3	4.8	869.99	ab.
D	3	21.5	9.0	891.77	ab.
BCD	6	6.3	3.6	1040.00	a.
ABC	6	11.0	5.5	927.47	ab.
AD	6	22.2	11.7	739.21	bc.
ABCD	9	4.6	5.3	912.95	ab.

Yield with the same alphabets are not significantly different at 5% level (Duncan's multiple Range Test). About 49.34% crop was lost in the control plots (0).

A significant increase in yield was obtained by spraying at phases BCD (flowering and pod maturation phase) six times at weekly intervals. The damage to flowers and pods was very low in phases BCD and ABCD.

Pests of Rice:

Pest population—Biology

The rice crop at Rice Research Station, Badeggi is attacked by several insect pests, of which the most prominent are the stem borers, plant and leaf-hoppers, bugs and beetles. Light trap collection of the major rice pest was carried out twice a week, throughout the period under report. The most abundant periods of occurrence of the various pests (adults) are shown below:

Pest sp.	Periods of Occurrence
Sesamia calamistis	February, November
Chilo sp. **agamenon**	February-March and Sept.-November
Maliarpha seperatella	Throughout the year but most abundant during March, May and October.
Scirpophaga sp.	May and September-November.
Adelpherupa flavescens	May, July, September-November.

The detailed study of the life history of the pests in the laboratory revealed that large numbers of eggs could be obtained from **Scirophaga** sp; **chilo** sp. and **S. calamistis** whereas, **M. seperatella** and **H. subeostella** proved very difficult to rear. Some of the developmental characteristics of the pests resulting from laboratory observations are shown below:

1 *Pest species*	2 *No. of eggs laid and location on the leaf*	3 *Hatching Period (days)*	4 *Larval development period (days)*	5 *Pupal development period (days)*
Sesamia calamistis	50-100 in rows inside the leaf sheath	4–7	41.2 (Mean)	13.0 (Mean)
Chilo sp. **agamenon**	120-200, flat and laid overlapping each other; upper or under surface of leaf sheath near the mid-rib	4–6	30–46	5–9
Sciropophaga sp.	40-100. Upper surface of leaf blade	8–10	118	10–15
H. subcostella	No definite data available	7	No data	10–16

Stem-borer larvae population

Rice plants sampled from July 1968 to February 1969 at Badeggi showed that the main species during July was chilo sp. while during August and September, **M. separatella** predominated and subsequently **H. subcostella** was collected in large numbers as shown in Table 22 below: Sevin 85, Diemcron 20, Thiodan 35, Texaphene, DDT, Basudin 20 and Gardona 24.

Table 22: Stem-borer larvae population during rice growing season, 1968-69

Month	*No. examined*	*% bored*	*Total No. of larvae*	*% Larvae collected*				
				Sesamia	*Chilo*	*Scirpa*	*Hypae*	*Maliarpha*
July	900	2.0	2	—	100	—	—	—
August	1350	3.7	5	—	20	—	—	80
September	1350	3.6	13	—	—	—	30.8	69.2
October	3600	17.9	254	2.8	4.7	1.2	73.2	18.1
November	1800	24.4	272	1.9	1.1	0.1	90.8	5.1
December	2250	29.8	396	8.8	1.0	5.1	82.1	3.0
January	450	13.5	19	—	—	5.3	78.9	15.8
February	450	14.9	23	17.4	—	—	82.6	—

The damage, initially low (2.0-3.6%) during July to September, increased subsequently to become the highest during December when 29.8% of the 2250 tillers examined were bored.

Another investigation showed that nearly 38.9 to 63.2% of the tillers in the affected hills were bored thereby causing yield losses. The most predominant species collected was **H. subcostella** while the population of the others was low:

Stem-borer population and age of crop

Samples of affected tillers were taken at 3 weekly intervals between July and October in 1968-69. Each sample comprised fifty tillers, each of three varieties, namely, KAV 12, BG 79 and MAS 2401. Stem borer larvae collected from dissected tillers showed that nearly 76.8 to 86.3% of all larvae belonged to the species **H. subcostella.** The data on the effect of age and variety on the infestation at Badeggi is given in Table 23:

Table 23: Effect of date of transplanting, age and variety on the incidence of rice stem-borer damage at Badeggi, 1968.

Date of transplanting	*Age of sampling (week)*	*% tillers bored of*		
		KAV 12	*BG* 79	*MAS* 2401
17:7:68	3	2.0	0.7	1.5
	6	4.0	2.0	2.0
	9	8.7	7.3	10.7
	12	13.3	3.3	5.4
	15	38.0	38.0	26.0
	18	45.3	32.7	47.7
	21	35.3	28.0	41.3
14:8:68	3	0.7	0.7	0.0
	6	0.7	2.7	2.0
	9	1.3	4.0	1.3
	12	16.0	13.3	20.0
	15	43.3	42.0	40.0
	18	59.3	48.7	42.7
	21	58.0	53.3	31.3
18:9:68	3	0.7	3.3	0.0
	6	3.3	4.0	6.7
	9	10.7	0.0	5.3
	12	6.7	12.7	16.0
	15	40.7	40.7	20.7
	18	39.3	42.0	44.0
16:10:68	3	0.0	0.7	0.0
	6	0.0	0.0	0.0
	9	0.7	1.3	0.0
	12	7.3	14.0	11.3
	15	13.3	15.3	17.3
	18	12.0	9.3	19.3
	21	19.3	12.7	12.7

The above results of 1968-69 indicate that borer damage increased with the age of the plant and was most severe in July-September plantings.

Insecticides trials

Thirteen insecticides were applied to the irrigation water at 7, 37 and 67 days after transplanting in an experiment during 1968-69. The insecticides used were: Agrocide 26, Gammexane 50, Gammalin 20, Nagos 50, Thiocron 30, Carbicron 50, Nuvacron 60.

The white head percentage at harvest varied from 0.9 to 2.4% in treated plots and was 1.7% in the untreated control plots. No significant yield difference was obtained between treated and untreated plots. The results are given in Table 24 below:

Table 24: Effect of insecticides on rice stem-borer control

Insecticide	*Rate of application (a.i.)/acre*	*% stem bored*	*No. of larvae*	*% dead hearts*	*% white heads*	*Yield (lbs/ acre)*
Gammexane	2½ lbs	16.0	13.0	19.2	1.8	3029.9
Agrocide	3 lbs	3.5	1.0	9.2	1.1	3141.0
Gammalin	3 lbs	5.0	—	12.2	1.9	3418.8
Nogos	3 oz	41.5	60.0	23.3	1.5	2838.5
Thiocron	100 ml	45.5	66.0	28.3	2.4	2800.8
Carbicron	8 oz	44.0	58.0	16.9	1.6	2884.6
Nuvacron	4 oz	33.5	49.0	14.2	1.4	2876.1
Sevidol	3 lbs	6.0	1.0	11.7	1.1	3174.4
Demecron	6 oz	52.0	60.0	24.4	1.4	2785.5
Thiodan	500 ml	1.0	—	10.4	0.9	2930.8
Toxaphene and DDT	3 litre	30.5	31.2	19.2	1.6	2721.4
Gardona	¼ lb	20.0	14.0	9.2	1.3	2752.1
Basudin	1½ lb	38.0	36.0	12.5	1.5	2564.1
Control	—	49.5	61.0	24.1	1.7	2542.7
L.S.D. (P=0.05)		11.2		9.3	0.8	651.3

Sugar cane Nematodes

Sugar cane is an important crop in Nigeria, and is grown throughout the country especially, in the north for making raw sugar and for chewing. It is grown commercially in a plantation of approximate acreage of 8000 acres at Bacita, near Jebba, Northern Nigeria at which is located a factory for sugar manufacture. Earlier surveys have shown the prevalence of parasitic nematodes which could cause economic losses in sugar cane at the estate. In the affected fields, patchy growth, poor ratooning and decrease in size of

the cane are all obviously discernible symptoms. However, the complex distribution of widely varying soil types at Bacita, on which sugar cane is grown, makes the problem of nematode attack a highly complex matter.

It is, therefore, difficult to assess the extent to which the depression in yield of sugar cane at Bacita could be ascribed to nematodes.

A recent survey of the injurious nematodes affecting sugar cane at Bacita has revealed the presence of a number of plant parasitic nematodes. The following 15 general were

(1) **Pratylenchus** sp.
(2) **Paratylenchus** sp.
(3) **Tylenchorhynchus** sp.
(4) **Helicotylenchus** sp.
(5) **Scutellonenra** sp.
(6) **Hoplolaimus** sp.
(7) **Criconenoides** sp.
(8) **Hemicriconenoides** sp.
(9) **Hemicycliophora** sp.
(10) **Trichodorus** sp.
(11) **Xiphinema** sp.
(12) **Longidorus** sp.
(13) **Dolichodorus** sp.
(14) **Meloidogyne** sp.
(15) **Heterodera** sp.

In many cases more than one species of each of these genus of nematodes were found to occur in a single sample. Some of the plant parasitic nematodes were found to be root as well as soil inhabiter while others were found in soil only.

A general survey of the parasitic nematode species in the Bacita Plantation has been done and the species identified are given in the following table:

Table 25: Parasitic Nematodes at Bacita

1. *Species*	*Functional Name*	*Remarks*
1. **Meloidogyne incogita** (Kofoid and white)	Root Knot Nematode	Plants stunted and chlorotic. Fairly large population, in sandy soils than in clay soils.
2. **Heterodera socetari** (Luc Merny)	Cyst nematode	Stunted plants mainly found in sandy soil.
3. **Pratylenchus** sp.	Root lesion nematode	Affected roots thickened with necrotic colourless brown lesions. Most dominant species at Bacita, irrespective of soil type and cane variety grown.
4. **Paratylenchus** sp.	Pin nematode	Small number only. No serious damage expected.
5. **Tylenchorhynchus** sp.	Stunt nematode	Most important and widely distributed parasitic nematode of sugar-cane at Bacita. Affected roots were blunt, coarse, shrivelled and sperse plants stunted and chlorotic giving symptoms of numiral deficiency.
6. **Helicotylenchus** sp.	Spiral nematode	Most soil inhabiting-wide spread. No definite visible symptom established yet.
7. **Criconenoides** sp.	Ring nematode	Isolated from clay soils. No definite information yet about pathogenity.
8. **Hemicychophora** sp.	Sheath nematode	Root tips club shaped where population was high. Plants stunted and chlorotic.
9. **Trichodorus** sp.	Stubby root nematode	Occurring in all soil types. Root system of affected plant in some fields appear reduced
10. **Xiphinema** sp.	Dagar nematode	Small numbers and no definite information on its parasitism
11. **Longidorus** sp.	Needle nematode	Fairly high population in some of the clayey soil types. No information on parasitism available.
12. **Dolichodorus nigeriensis** (Luc and Caveness)	'Awl' nematode	Infrequently occurring. Type of damage not known.

From the present survey, it can be definitely established that soil type plays a distinctly important role in nematode distribution. **Pratylenchus Tylenchorhynchus** and **Helicotylenchus** were the most widespread and abundant species found in both soil and roots in almost all soil types ranging from sands to heavy clays. Root knot nematode **Meloidogyne incognite** appeared more frequently on almost all crops in Nigeria.

Most plant parasitic nematode species are known to cause greater crop damage in high sandy soils than in heavy clay soils. Their occurrence in higher number in light sandy soil may be one of the major limiting factors for crop growth in such soils. In Bacita Estate, the nematodes seem to be far more numerous in light sandy loam soils and clay soils.

Examinations carried out in the field and laboratory indicate that sugarcane is a good host and that nematodes are responsible for sugarcane yield decline and could cause appreciable losses. It appears inadvisable to grow sugarcane repeatedly in poor sandy soils. Corrective measures like eradication of weeds and grasses, which may possibly serve as indirect hosts and also of adequate protection through soil fumigation are some of the steps which need careful consideration and further investigation. Fumigation is a costly operation and is likely to increase the cost of the commercial crop grown repeatedly on poor sandy soils.

PLANT PATHOLOGY DIVISION

Plant Disease Survey

As a result of a series of surveys based on field and laboratory seed health tests, it was confirmed that brown leaf spot disease was remarkably more important that blast disease on upland rice. Table 26 shows the results of survey conducted on seed samples from 1964-67 crops in the different states:

Intensity of Brown leaf spot infection

Twelve varieties of rice were inoculated under high humidity condition to obtain a good range of infection to evolve a standard scale of intensity of the disease on mature rice plant. A scale of 1 to 6 ranging from very light to very severe attack was developed from the results. These, along with pictorial charts developed for the purpose, were adapted for routine measurements.

Plate 1. Pictorial Scoring Chart for brown Leaf-Spot disease of rice

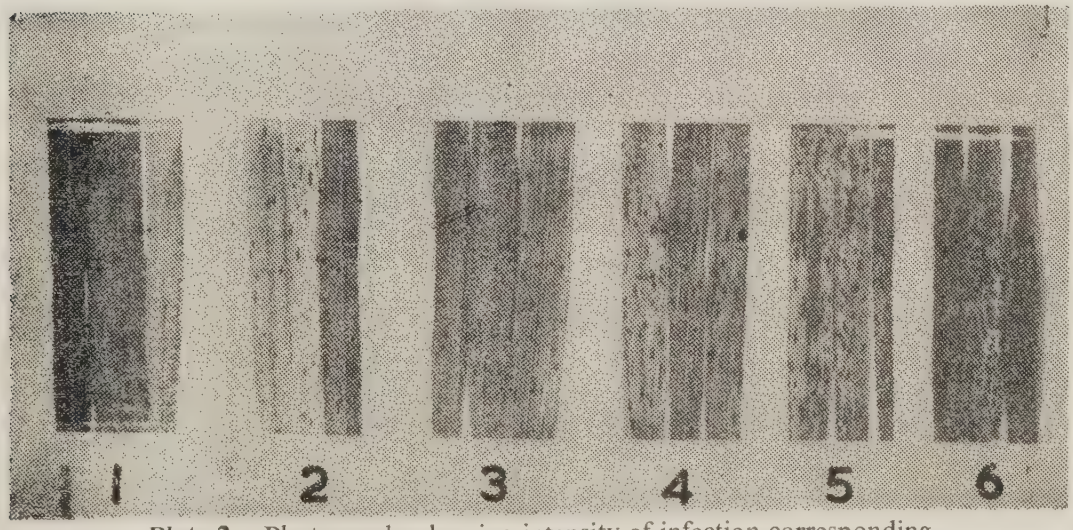

Plate 2. Photographs showing intensity of infection corresponding with the Pictorial chart in plate 1

Table 26: Incidence of Helminthosporium oryzae and Pyricularia oryzae on upland rice seed, 1964-67

Regions	*Number of Samples*	*Helminthosporium oryzae*		*Pyricularia Oryzae*	
		% of Samples infected	*Mean % Infection on infected samples*	*% of samples infected*	*Mean % infection on infected samples*
Western	122	80.9	20.4	10.3	1.3
Midwestern	26	84.9	13.2	8.4	1.8
Eastern	8	87.5	11.5	0	—
Northern	23	82.8	5.6	4.2	0.5
Overall %	—	81.9	16.7	8.4	1.4

Seed dressing

Five seed dressing chemicals were compared in a trial at Ibadan and Ikenne to determine the economic significance of planting infected seeds of OS-6. Of these five seed dressings tested, only Fernasan 75W and Aldrex T caused about 10% improvement in plant stand and none of them was able to show any significant increase in yields. Thiotox was apparently phytotoxic in causing a significant loss in yield even of plants raised from healthy seeds. The results are shown in Table 27.

Table 27: Seed dressing trial 1968 (Yield in lbs/acre)

Treatment	*Ibadan*			*Ikenne*		
	Relatively healthy seeds	*Infected seeds*	*Main Treatment means*	*Relatively healthy seeds*	*Infected Seeds*	*Main treatment Means*
Thiotox	17.0	15.4	16.2	12.8	11.7	11.8
Fernasan 75W	19.4	18.1	17.7	13.7	12.9	13.3
Dithane 1745	20.1	17.9	19.0	15.2	11.9	13.6
Aldrex T	22.3	19.9	21.1	13.9	11.3	12.6
Quinolate 15/40	23.6	19.4	21.5	13.5	12.5	13.0
Control	21.1	19.1	20.1	14.1	10.7	12.4
Subtreatment Total	123.5	107.8	—	83.2	71.0	—
L.S.D. (P=0.05)	1.70	1.70	3.1	N.S.	N.S.	N.S.

N.S. = Not significant.

Loss of yield due to brown leaf spot disease

An experiment was conducted at Ibadan, Wasimi, Kotopo and Ikenne to determine the extent of loss in yield caused by Helminthosporium oryzae infection on upland rice OS-6. Three folial spray chemicals namely, Dithane M45, Blasticidin and Fernide were applied at fortnightly and monthly intervals in order to compare trial respective efficacy in controlling the disease.

Significant yield increase (25%) was obtained at Wasimi by fortnightly spray with Fernide at 2gm/litre. No yield increases were obtained at the other stations which may have been due to plant infection being negligible (Ibadan) or infection being minimal (Ikenne and Kotopo). Among the plant protection chemicals used, Fernide was more effective than both Dithane M45 and Blasticidin in reducing infection. However, none was able to produce complete control of the infection (Table 28).

Table 28: Loss of Yield due to Helminthosporium infection at four sites in Western State, 1968 (Yield in lb per plot)

Chemical used	*Ikenne*	*Ibadan*	*Kotopo*	*Wasimi*
Dithane	13.6	13.7	10.7	12.3
Blasticidin	15.2	11.8	11.3	11.0
Fernide	16.1	16.6	9.2	13.8*
Control	12.9	15.2	10.0	9.0
L.S.D. (=0.05)	N.S.	N.S.	N.S.	4.2

*Significant at P = 0.05 N.S. = non significant

Varietal resistance to brown leaf spot infection and perenation of the fungus

Forty rice varieties were received for assessment of resistance to Helminthosporium infection at the flowering stage. Among these, three swamp varieties, namely, SML.140/10, SML.18/B and Mali Ong were found to be resistant. Eight varieties, including OS-6 were moderately resistant while the remaining ones, including OS-4, EA25 and local Agbede, were susceptible.

Investigation on the dry season survival of the causative organism of brown leaf spot disease showed that the fungus survived within both infected seeds as well as the stubble left over from the previous crops. Amongst other pathogen found to survive within the crop residues were species of **Curvularia** and **Nigrospora.**

Symbiotic Nitrogen Fixation

Studies aimed at improving the dry matter content and crude protein of pasture legumes were commenced with two strains of **Rhizobium,** namely, CPL 1 and CPB 1 employing seed inoculation techniques. The rhizobia were isolated from pasture legumes, **Centrosema plumieri** and **Centrosema pubescens.** Very effective inoculation was obtained in **C. pubescens.** Table 29 shows that inoculated plants yielded about four times the dry matter and more than five times the nitrogen content of the uninoculated controls.

Soil Nitrification Studies

Previous work (Annual Report, 1967/68) indicated the possible influence of the cover crop on the process of nitrification in soil. Further experiments were conducted with soil samples taken from six ecotypes of **Panicum maximum** including four each receiving 100 lb/acre of nitrogen. Using soil Perfusion technique, results indicate that nitrification was higher under the four imported ecotypes from Kenya than the local strains. The rate of nitrification in eight soils was studied under different crops. Cocoa soils gave 380 ppm No_3-N by the 14th day of perfusing. During the same period, soils under Pueraria **phaseoloides** reached 220 ppm and **Centrosema pubescens** 190 ppm respectively. Upland rice occupied an intermediate position while the process under the three ecotypes of **Pennisetum purpureum** was the slowest.

Table 29: Response of Centrosema pubescens to inoculation with two strains of Rhizobium CPL 1, CPB

Table 29A: Mean Total Nitrogen in mg (Roots, Leaves and Stems)

Date	*CPL* 1	*CPB* 1	*Control*
22. 7.68	20.57	22.57	8.80
5. 8.68	60.05	31.00	15.56
29. 8.68	112.14	147.86	39.06
17. 9.68	159.79	209.95	39.12
25. 9.68	193.45	231.93	66.77
8.10.68	185.16	396.34	33.81
17.10.68	422.02	436.74	75.95
4.11.68	470.33	521.61	70.49
13.11.68	488.1	736.69	30.99

During the vegetative growth, prior to flowering, most of the nitrogen was located in the leaves. A highly positive correlation was obtained between the activity of the nodules and the entire growth of the plants under limiting conditions of nitrogen.

Table 29B: Mean total dry matter in gm. (Roots, Leaves, Stems)

Date	*CPL* 1	*CPB* 1	*Control*
22.7.68	0.85	0.82	0.53
5.8.68	2.42	1.30	0.80
29.8.68	4.30	5.70	1.57
17.9.68	7.78	9.28	2.28
25.9.68	12.33	11.13	3.50
8.10.68	12.46	17.68	2.03
17.10.68	16.68	19.50	3.73
30.10.68	19.05	21.18	3.94
4.11.68	20.15	24.18	4.75
13.11.68	23.18	26.80	2.32

RICE RESEARCH STATION, BADEGGI

Rice Breeding

Four major rice growing ecological zones of Nigeria are the naturally inundated lowlands, the non-inundated irrigable lowlands, the rainfed upland and the fresh water mangrove swamps. Rice varieties being highly selective in adaptation, no single variety is known to be adapted to the major ecological zones. Varieties adapted to one ecological zone cannot successfully thrive in another. For this reason, the rice breeding and agronomy research programmes are divided and related to the individual zones.

The Naturally Inundated Lowlands Programme

Based on previous breeding trials, **Oryza sativa** variety Mali-Ong was recommended in Birnin Kebbi area of the Sokoto valley where the red-grained floating variety, **Oryza glaberrima,** is traditionally grown. However, the too long growing period of the above recommended variety prompted further breeding programme to be undertaken to produce an earlier maturing, floating type than Mali-Ong.

Variety Trials

Two popular high yielding **Oryza glaberrima** varieties and 15 white grained **Oryza sativa** varieties were compared with Mali-Ong. At Birnin Kebbi, the varieties produced significantly different yields from one another. Compared to Mali-Ong, the six varieties, namely, Indochine Blanc, Malobadian, Nang Rai, Indo-Chine A, Godalaki III and Bada-

nde gave significantly higher yields in that order of merit. Among these, Indo-Chine Blanc was found to be the most significantly highest yielding variety with maturity of 37 days earlier than Mali-Ong but having a floating habit that is not as good as the latter.

At Badeggi, seven floating varieties, with maturity earlier than Mali-Ong by 40 to 60 days, were obtained. However, all of them were significantly lower yielding than Mali-Ong by 30 to 60 per cent. Two others were higher yielding but later in maturity by 15 days than Mali-Ong.

Breeding for Early maturing Floating Type

The present breeding programme is a continuation of the hybridization project started in 1960, when three high yielding, long duration, floating varieties were crossed with the short duration Indo-Chine Blanc. The main objective has been to produce high yielding floating varieties of short duration than Mali-Ong.

In 1966, forty plant pedigree lines with a good floating habit, early maturity and high yielding potential characters were selected from the 109 individual plants in a replicated progeny yield trial. During the year under review, the pedigree lines in their F_8 and F_9 generations had completed three years of testing in yield trials. As a result of the highly significant yield differences obtained over a period of three years and their significant adaptability, the following five highest yielding and early maturing lines were selected, namely, 41/12/2, 41/8/2, 41/19/1, and 41/2/1. They are earlier in maturity by 15 to 20 days and gave 75 to 99% higher yield than Mali-Ong.

Interspecific Hybrids

In continuation with earlier interspecific hybridization programme (**Oryza sativa** × **O. glaberrima)** through advanced generations for increasing yield, fifteen selected pedigree lines were compared in a replicated progeny yield trial with **O. glaberrima** variety Dan Boto and two standard varieties **O. sativa,** namely, Mali Ong and Indo-Chine Blanc. Highly significant yield differences between the yields of interspecific hybrids were obtained but none gave significantly higher yields than the control varieties, Mali-Ong and Dan Boto. The yields of all the interspecific hybrids were very low ranging between 300 to 1400 lbs per acre.

The non-inundated irrigable low land programme

Although high yielding, and with a wide range of environmental tolerance, BG 79, the variety most widely used in the shallow swamp rice zone, suffers from problems of long duration, particularly in specific areas and high susceptibility to blast disease. The breeding programme for this zone has been directed mainly towards the development of new varieties with the following desirable characters:

(*i*) shorter maturity period of 110-120 days
(*ii*) photoperiod insensitivity with wide adaptability
(*iii*) medium duration of maturity—either earlier than BG 79 or similar to it (140-160 days)

(*iv*) high yielding and high blast resistance

(*v*) non-lodging and highly responsive to application of heavy rates of nitrogenous fertilizer with better and improved vegetative characters.

Variety Introduction

World collection: 405 varieties received from different countries were classified into short, medium and late duration in maturity and were compared with replicated control plots of Puang Ngeon, BG 79 and Mas 2401. Forty of the varieties tested were early maturing type (90 to 125 days). Amongst the new promising varieties giving a significantly higher yield than the control, seven were outstanding with yield increases over control ranging from 50 to 114 per cent as shown in the trials reported below.

Variety Trial

The trial of eleven varieties selected from the 1965 variety collection was concluded after its third year of test. The results indicate that all the short duration varieties (130 to 140 days) Telep, Perola, Very-lava-16, Kotapalla and Blue bonnet gave significantly lower yields than the medium duration varieties (145 to 156 days) H5, Makalioka-823 and Puang Ngeon.

Comparative studies of the imported long grained SML varieties (from Surinam) with standard swamp varieties BG 79 and Mas 2401, along with 19 other medium duration varieties selected from variety collection at Badeggi between 1966 to 1968, showed that SML 140/10 produced significantly highest yield among all the varieties tested. Table 30 gives the yield data obtained from these trials.

Table 30: Comparing the yield on SML varieties with BG 79 and Mas 2401 at Badeggi 1966-1968 (lbs/acre)

Variety	1966	1967	1968	*Average*	*Remarks*
SML 140/10	2867	2435	3397	2906++	Non-lodging
221/B1.iv/1/178/9	2730	3316	1658	2568	Lodging
Murungakayan	3329	2618	1603	2550	Lodging and red grained
SML-81-13	2718	2337	2303	2455	Non-lodging
SML-140/5	2667	2433	1536	2211	,,
SML-352	2690	1603	1562	1952	,,
BG 79	2147	1861	1698	1902	Lodging
Mas 2401	2255	1780	1182	1706	,,

Highly significant difference in yield over Mas 2401 (P=0.01)

The variety SML-140/10 has outyielded the standard varieties BG 79 and Mas 2401 in all the three years' tests. It has produced significantly increased yields of 52.7 per cent and 70.3 per cent over those of BG 79 and Mas 2401 respectively.

Similar outstanding yields in comparison to standard varieties BG 79 and Mas 2401, were obtained at six centres. The results are summarised below in Table 31:

Table 31: Comparison of yields of six varieties of rice at six locations, 1968

Variety	*Badeggi*	*Bende*	*Abakaliki*	*Wurno*	*Bakura*	*Yola*	*Mean*
SML 140/10	2880+	2063++	4984+++	3895+	3964	3683	3743
SML 140/5	2215	3812	5690+++	3024	3432	2678	3475
SML 81-13	2460	2735	3753+++	3560	2696	3125	3051
SML 352	1960	3095	3673+	2365	—	3497	2918
BG 79	1905	1615	2941	—	3984	—	2611
Mas 2401	1742	2333	1849	3480	3562	3385	2725

\+ Significant difference between variety and standard (p=0.05)
++ Highly significant difference between variety and standard (p =0.01)
+++ Highly significant difference between variety and standard (p- -0.001)

On the basis of its superior yield performance over the standard at all the sites, SML 140/10 was found to be the most suitable high yielding, early maturing, non-lodging swamp rice variety and is now recommended to replace the standard swamp varieties BG 79 and Mas 2401.

(*iii*) **Regional Variety Trial**

Considerable environmental variations exist within the non-inundated irrigable lowlands. It is often possible to recommend new varieties superior to BG 79, for specific area within this zone.

Short duration varieties are required to fit in with the double-cropping system of the rice-wheat areas. A comparative study of fourteen varieties including the four SML lines and eight blast resistant types, namely, H4, H5, Tadukan, Peta, BP1-76, HMA 9, Murungakayan and IR-8, was made with Mas 2401 and De Gaulle on three sites at Wurno, Yola and Combaru under irrigation. The highest yielding variety at Wurno was De Gaulle but it did not differ significantly from varieties HMA9, IR-8, H5, BP1-76.

However, all of them were significantly higher yielding than Mas 2401. SML varieties did not produce significantly higher yields than De Gaulle, IR-8 and HMA-9. At Yola, HMA-9 gave the highest yield of all and was significantly higher yielding than all the four SML lines, IR-8 and BP1-76. De Gaulle did not produce significantly higher yield over

HMA-9. At Gambari, De Gaulle was the highest yielding variety although it gave poor yield of 1227 lbs per acre which did not differ significantly from the closely following varieties H5, H4 and BP1-76 while HMA-9 gave significantly lower yield than De Gaulle.

Table 32 summarizes the yield performance of ten varieties under the irrigation scheme at Bakura. The varieties tested were: OS-6, IR-8, IR-5, De Gaulle, SML 140/10, SML 140/5, SML-81-13, BG79, HMA-9 and Mas 2401. They were grown on an area of one acre each with seed rates of 60 lbs per acre for all varieties except OS-6 which was sown at 15 lbs per acre by dibbling 4-6 seeds per hole 9 ins × 6 ins apart with irrigation applied afterwards.

The data (Table 32) shows that the highest yield was obtained from HMA-9, followed closely by IR-8 and SML-140/10 which were both high yielding and non-lodging and they required fewer irrigations than the lodging types, viz: HMA-9, BG 79 and Mas 2401.

Table 32: Yield performance of ten rice varieties under lift irrigation

Variety	*Date of Planting*	*Date of 50% Flowering*	*Yield in lbs/acre*	*Number of irrigation*	*Life period in days*	*Remarks*
1. OS-6	11/6/68	6/9/68	2229	6	118	25% lodging
2. IR-8	10/6/68	18/9/68	3764	10	130	Erect, No lodging
3. IR-5	6/6/68	28/9/68	3960	12	140	30-40% lodging
4. De Gaulle	5/6/68	2/10/68	2832	11	144	80% lodging
5. SML-81-13	5/6/68	2/10/68	2693	10	144	Erect; No lodging
6. SML-140/5	4/6/68	2/10/68	3432	10	144	—do—
7. SML-140/10	4/6/68	2/10/60	3964	12	144	,,
8. BG 79	4/6/68	14/10/68	3984	14	155	Lodging
9. HMA-9	4/6/68	12/10/68	4500	14	160	—do—
10. Mas 2401	4/6/68	23/10/68	3562	14	160	—do—

(*iv*) Variety trial to suit double Cropping

A pilot trial to test short and medium duration varieties in suitable combinations for raising two rice crops on the same land was conducted at Badeggi. First season rice was made up of varieties having low and weak photosensitivity. In the second season, each plot was split for three varieties, namely IR-5, OS-6, and SML 140/5. The results are summarized in Table 33.

Table 33: Yield of Rice Varieties grown in Double Cropping rice culture at Badeggi, 1968

First Season				*Second Season*			
Varieties and Date of Planting	*Harvest Date*	*Yield in lbs/acre*	*Variety*	*Date of Trans-planting*	*Date of Harves-ting*	*Yield in lbs/ acre*	*Total yield in lbs/acre of Double Rice crops*
Taichung Native I 25/4/68	4/9/68	3556	IR-5	18/9/68	22/1/69	5438	8994
			OS-6	18/9/68	13/12/68	1182	4738
			SML 140 /5	18/9/68	18/12/68	4212	7766
Milfor-6 25/4/68	4/9/68	1980	IR-5	29/9/68	22/1/69	3385	5365
			OS-6	29/9/68	31/1/69	2500	4480
			SML 140 /5	29/9/68	22/1/69	4313	6219
IR-8 25/4/68	24/9/68	3019	IR-5	10/10/68	21/1/69	3097	6116
			OS-6	10/10/68	21/1/69	1500	4519
			SML 140 /5	10/10/68	31/1/69	3231	6250
Makalioka 823 25/4/68	25/9/68	2117	IR-5	21/10/68	5/2/69	3423	5540
			OS-6	21/10/68	14/12/68	468	2585
			SML 140 /5	21/10/68	18/2/69	3192	5209
SML 140/5 25/4/68	25/9/68	2693	IR-5	24/10/68	31/1/69	2235	4928
			OS-6	24/10/68	31/1/69	353	3046
			SML 140 /5	24/10/68	5/2/69	1471	4164

From the data presented above, the best combinations of rice varieties suitable for two rice crops in a year would appear to be: (*i*) Taichung Native I followed by IR-5 or SML-140/5, and (*ii*) IR-8 followed by SML-140/5 or IR-5 to produce maximum yields.

Breeding short duration varieties

Selections from hybrid materials from breeding programme started initially in 1959, were continued for developing shorter duration varieties than BG 79. Among the eighteen progenies screened for susceptibility to blast on International Uniform Blast Nurseries, six were selected for yield trial. Progenies 40/109 and 25/10 gave significantly higher yields than 39/79 but were significantly lower in yield than Mas 2401, the standard variety used for comparison. The lowest yielding progeny 39/115 was a dwarf type and having very early maturity of 120 days.

Breeding for lodging resistance

A new breeding programme was initiated in 1967 in place of the old one to develop varieties having lodging resistance and improved ideal plant types with characters of short and erect stems, non-photosensitivity and wide adaptability, high responsiveness to heavier rates of application of nitrogenous fertilizers and early maturity. The selected donors

parents for these characters were: IR-8, Taichung Native I ($T.N_1$), FRRS 39/115 and B-572 Az, 47-2-4P. These were crossed with three tall and lodging susceptible varieties Mas 2401, BG 79, Tjina and also with two non-lodging varieties BP_1-76 and SML 140/10. Observations on the morphological growth, flowering and agronomic characters of the 24 F_1 hybrid combinations were noted upon planting in the field. Dominance of parental characters was clearly seen from the F_1 hybrid population in these crosses. The dominant characters of parent varieties observed were as follows:

1. Short height and improved plant type of IR-8 and TN_1
2. Early flowering of B-572-A_3-47-2HP, IR-8, and TN_1
3. Erect leaf growth of IR-8, TN_1, and SML 140/10
4. Heavy Tillering of IR-8
5. Stiff culm of IR-8 and SML 140/10

Breeding for resistance to Pyricularia Oryzae

Selection of blast resistance varieties

At Badeggi, all rice varieties in the collection and all the hybrid lines in the station trial varieties are screened each year in the continuing search for blast resistant gene by the International Uniform Blast Nursery Technique. Among the 624 varieties tested in 1968, the following classifications were obtained:

No. of Varieties	Degree of Resistance to Blast	Class
45	Highly resistant	0–1
55	Resistant	1–2
235	Moderately resistant to susceptible in seedling stage	2–5
151	Highly susceptible in seedling stage	5–7

An experiment was conducted with 16 varieties at Badeggi and Shendam in the lowlands of Plateau province to study the environmental effectiveness of the blast resistance of these varieties. The latter site offered a more conducive climatological condition than the former for the quick development and intensification of infection of the pathogen. It was observed that there was considerable modification in the degree of resistance of the varieties when planted under different environmental condition. However, the results of the yield data indicate that infection of blast at seedling stage did not affect the varietal yields adversely. Thus, at Badeggi, variety BP_1–76 gave the highest yield of 3264 lbs per acre followed by H_4 and SML 140/5 with 2870 and 2766 lbs per acre respectively. All these varieties gave significantly higher yield than BG 79, Mas 2401 and GEB 24/37. No significant differences in yield were obtained among the varieties at Shendam where the highest yielders were SML 140/10, SML 140/5 and BP_1-76 respectively.

Breeding for Blast resistance

In 1964, eight blast resistant varieties were crossed in a diallel programme to produce blast resistant varieties. Twenty hybrid combinations from these crosses were compared with the susceptible control varieties D99 and Mas 2401 by screening them on International Uni-

form Blast Nurseries for blast resistance at Badeggi. These were subsequently tested in the field for yield and blast infection. This testing was continued from F_3 to F_5 generations and in each successive generation the susceptible individuals from the hybrid progenies were discarded.

During this year in F_5 generation, most of the hybrid progenies attained homozygosity regarding plant form, height, flowering and grain characters. Their average performance of reactions to blast resistance, which was found to change through each generation, is summarized by the measure of the susceptibility index calculated on the basis of their reaction (Number of Resistants, Intermediates and susceptibilities) through all the five years is given in Table 34 below:

Table 34: Reaction of Blast Resistant Hybrids through F_1 to F_5 generations in International Uniform Blast Nurseries, Badeggi 1965-1968.

Hybrid progeny from crosses	*Reaction to blast scored or IUBN*						*Susceptibility*	*Remarks*
	F_1	F_2	F_3	F_4	F_5	*Average*		
1. Tadukan × BP_1-76	1	2	3	2	4	2.25	2.83	Discarded
2. H_4 × Peta (Med)	1	1	4	2	2	2.0	2.60	—do—
3. Tadukan × H_5	1	1	1	3	3	1.6	1.75	MR
4. Tadukan × Tjina	1	1	1	2	2	1.4	1.00	HR
5. Acheb × H_5	1	1	1	2	2	1.4	1.00	HR
6. H_4 × Peta (Long)	1	1	4	2	2	2.0	2.60	Discarded
7. BP_1-76 × H_5	1	3	2	2	5	2.6	2.2	—do—
8. Peta × Tjina	1	1	3	3	2	2.0	2.2	—do—
9. Tadukan × H_4	1	1	2	2	2	1.6	1.0	HR
10. H_5 × Peta	1	1	2	2	2	1.6	1.0	HR
11. Ramihad H_4	1	1	2	2	2	1.6	1.0	HR
12. H_4 × H_5	1	1	3	2	2	1.8	1.66	MR
13. H_5 × Tjina	1	1	1	1	2	1.2	1.00	MR
14. H_5 × Tjina	1	1	1	1	2	1.2	1.00	MR
15. Raminad × Tjina	1	3	2	2	2	2.0	1.60	MR
16. Tadukan × Peta	1	1	2	2	2	1.6	1.00	HR
17. Tadukan Raminad	1	1	1	2	3	1.6	1.74	MR
18. Raminad × H_5	1	1	1	1	3	1.4	1.90	MR
19. BP_1-76 × Peta	1	3	3	2	3	2.4	2.50	Discarded
20. BP_1-76 × H_4	1	3	4	3	2	2.6	3.20	—do—

In the table on page 64, most resistant lines were considered to be those having the lowest susceptibility index of 1.0; those with the value of Index between 1 to 2 were considered moderately resistant (MR) and others having the value of 2.0 were considered to be susceptible and highly susceptible to leaf blast. On this basis, eight progenies were marked by highly resistant types (HR), and five were moderately resistant (MR).

The susceptibility of these progenies to infection of neck rot or panicle blast and its effect on final yield was studied in field tests. Observations based on the number of affected tillers per 25 randomly selected stand from each progeny were recorded as per cent neck rot. The most resistant progenies with score of 2.0 to 2.80 per cent neck rot infection proved to be highly resistant in seedling reaction tests to infection of blast. There were significant yield differences between the yields of the hybrid lines. Their yields varied from 5300 to 2060 lbs per acre as compared with the average yield of 1560 lbs/acre of Mas 2401. These high yielding progenies are the lines from crosses between (1) Peta $\times$ H_4, (2) BP_1-76 $\times$ Peta, (3) H_5 $\times$ Tjina, (4) BP_1-76 $\times$ H_5, (5) Peta $\times$ Tjina, (6) Tadukan $\times$ H_5, (7) Tadukan $\times$ H_4 and (8) H_4 $\times$ H_5.

Rainfed Upland—The National Zonal Upland Variety trials replicated at Jema'a and Wushishi in the North in 1966/67 series indicated that the variety—E.425, which is of shorter duration than OS-6 has greater potential than the recommended variety OS-6 in areas where rain water was limited.

In 1968, the trials were spread over larger areas and replicated at nine sites with the object of producing a recommended upland variety suitable for cultivation in the derived savannah areas of the North. A comparison of the results showed that the upland rice trial was best at Wushishi where all the six varieties produced highly significantly greater yields than their corresponding yields at other stations ($P=0.01$). Among the first two top yielding variety E.425 produced the highest first rank yields at five stations out of the nine trials whereas OS-6 attained the first rank at only two stations. The yield performances of the different top yielders at nine centres are summarized in Table 35 on page 66:

Table 35: Comparative yields of the upland Varieties with first and second ranks at different Stations.

Station	*Yields of Varieties in lbs/acre*			
	First Rank		*Second Rank*	
Wushishi	OS-4	4928	E.425	4773
Run fafiya	R.66	3612	OS-6	3291
Pankshin	E.425	2258	OS-6	2193
Kiri	OS-6	2369	R.66	1715
Ilora	OS-6	1858	Agbede 16/56	1754
Denga	E.425	1969	R.66	1914
Jema'a	E.425	1474	OS.4	1426
Ajasse	E.425	929	OS-6	722
Yola	E.425	867	Agbede 16/56	715

The results indicate that E.425 has higher yield potential and adaptability with in parts of savannah zone of the Northern States.

Variety trial for blast resistance

Yield trial of five progenies (55/4, 55/29, 57/29, 57/170, 56/215 and 56/230) selected in F_5 generation from the breeding programme commenced in 1967 to produce blast resistant upland variety, was continued. The progenies were compared with OS-6 and Chainan 8 along with the early and medium bulk hybrid materials of the crosses. The analysis of yield data showed that the highest yield of 1106 lbs per acre was obtained from progeny 55/4 which was closely followed by the early hybrid bulk and 55/29 giving 1077 and 1065 lbs per acre respectively. Progenies 55/4 and 55/29 were found statistically superior in yields than progenies 56/215 and 56/230 ($p=0.05$); but they did not prove significantly superior to OS-6 and Chainan 8, both of which were of shorter duration by 13 to 18 days. Furthermore, progenies 55/4, 55/29 and 55/215 were found to be slightly susceptible to infection due to **Helminthosporium oryzae.**

RICE PROCESSING

Investigations in Milling

As a result of the earlier investigations, all varieties at Badeggi station are tested for milling quality by two-stage milling process in the laboratory on the McGill Mill. Owing to the differences in shape and size of rice grains, a comparison correlation was made between the milling quality of some of the recommended varieties obtained from the laboratory mill with those of the industrial scale milling on the Grant Mill. Results of the study are summarized in Table 36.

Table 36: Comparison of Milling Qualities of rice varieties tested by two-stage milling methods on laboratory Mill and Industrial Scale Grant Mill

Varieties	*Percentage broken grain (average of 15 Samples)*		
	Lab. Mill	*Grant Mill*	*Remarks*
SML-140/10	29.43	28.38	Extra Long grains
SML-140/5	13.08	24.48	—do—
Mas 2401	13.77	16.17	,,
BG-79	8.74	10.39	,,
Mak. 823	6.27	9.05	,,
SML-352	11.88	13.31	,,
SML-81-13	9.76	15.20	Long grains
Mali Ong	17.51	26.61	—do—
OS-6	10.13	14.66	,,
Average	13.40	17.58	—

As may be seen from the above table, the percentage of 'brokens' was most higher for Industrial Grant Mill as compared to those from laboratory mill. A positive correlation, however, was found to be present between the results of the two milling sources tested.

Parboiling Studies: Investigations were directed towards soaking rice before milling. The traditional method of soaking in cold water for nearly four days usually imparts a disagreeable odour to the milled rice. To accelerate soaking, higher steeping temperatures (60°, 70°, 80°C) were found to be useful to improve the milling qualities of varieties Mas 2401, BG 79, Mali Ong and OS-6. These tests were further extended to include the SML varieties. Four soaking times of 4, 5, 6 and 7 hours at 60°, 70° and 80°C were tested. Statistical analysis of the data obtained showed that the milling quality of the varieties were significantly affected. The best method for reducing the percentage of *brokens* to a minimum was found to be the one involving a soaking period of 6 hours at 70°C for all the 4 SML varieties.

RICE AGRONOMY

The Naturally Inundated Lowlands

Fertilizer Trials: The response to fertilizers of the floating variety Mali Ong, commenced at Birnin Kebbi in 1964 was continued in 1968. Three levels of N applied at 0, 2 and 4 cwts per acre of Ammonium sulphate, two levels of P applied at 0 and 2 cwts per acre of single superphosphate and two levels of K applied at 0 and $1\frac{1}{2}$ cwts per acre of muriate of potash, were used in a $3 \times 2 \times 2$ factorial design with ten replications on two soil types. The fertilizers were applied broadcast before sowing and raked into the soil. Combined analysis of yield data for three years' test, on response of Mali Ong variety to the increasing

rates of applied NPK, did not show significant differences between the yields. However, a linear response for the yield increase due to increasing rates of N-application was found. Highest yields were obtained for the highest rate of 4 cwts per acre of ammonium sulphate but the differences were not significant over the lower rates of 0 and 2 cwts per acre. Also, application of 2 cwts per acre superphosphate gave no significant increase in yield over nil application, and there was also no response to application of 1½ cwts per acre of Muriate of potash.

The Shallow Swamps

Nitrogen Response studies—Investigations on varietal response to nitrogen were continued in 1968 to obtain further information on earlier results which indicated that the dwarf, short duration Indica varieties are more nitrogen responsive than the tall, long duration weak strawed types.

Three varieties, namely, IR-8 (dwarf type), SML 140/10 (medium tall and erect type) and Mas 2401 (tall, weak strawed lodging type), were compared to investigate their respective nitrogen responses to the applications of five increasing rates at 0, 1½, 3, 4½ and 6 cwts per acre of Ammonium sulphate. A split plot design, with six replications and nitrogen levels as main plots, split for variety was used for the experiment. Under increasing nitrogen levels, Mas 2401 showed significant increase in plant height compared with IR-8—but lodged severely while the latter did not lodge at all. Differences in yields due to increasing nitrogen levels were not significant but the yield response to nitrogen × variety interaction was significant ($p=0.05$). Increased yields due to higher nitrogen application (4½ and 6 cwts per acre of Sulphate of Ammonia) were found, in the case of IR-8, to be highly significantly greater than those due to control. Mas 2401 gave increasingly higher yields up to 3 cwts per acre level of ammonium sulphate which, however, were not significantly different from those of the control and the lower rates. At the higher rates of application (4½ and 6 cwts per acre) the yields of Mas 2401 were depressed. SML 140/10 responded erratically to different rates of application of sulphate of ammonia.

Plant Population Studies: Earlier investigations (1964-66) on plant density and nitrogen levels interaction was continued in 1968 to include varieties of different growth habits. A 3^3 confounded factorial design was used to study the effects of all combinations of three levels of nitrogen, 3 spacings and 3 varieties. IR-8, SML 140/10 and Mas 2401 were test crops in this trial; of the nitrogen levels were 0, 1½ and 3 cwts per acre of ammonium sulphate and spacings consisted of 8 × 2, 12 × 3 and 16 × 4 sq. ins. per plant. With increasing applications of nitrogen plant height of Mas 2401 increased significantly at closer spacing of 8 × 2 and 12 × 3 sq. in. per plant than at 16 × 4 sq. in. per plant. SML-140 10 also increased its plant height significantly but IR-8 showed no significant increase in plant height. On the other hand, the yield response of IR-8 was significantly greater at 8 × 2 sq. in. than at the wider spacing of 16 × 4 sq. inches. Mas 2401 increased significantly in yield at 16 × 4 sq. in. per plant than at closer spacing of 8 × 2 sq. in. The responses of SML-140/10 were not significant.

Direct Seeding trial: Direct seeding, broadcast or drilling offers great scope for mechanization than transplanting. An experiment, started in 1967, was continued in 1968 to study the effect of varying seed rates on the establishment and yield of Mali Ong sown by mechanical drilling. Five seed rates: 40, 60, 80, 100 and 120 lbs per acre were tested by adjustment to the mechanical seed drill (John Deere) and were drilled in rows 12 inches apart. Highest yield of 2080 lbs per acre was obtained from the lowest seed rate of 40 lbs per acre while the lowest yield of 1877 lbs was obtained from the highest seed rate of 120 lbs per acre. However, the difference between the yields due to seed rate treatments were not statistically significant.

Crop rotation studies: Previous work started in 1964/65 indicated beneficial effects from a rotation of rice and cowpeas. Seven cowpea varieties were tested in 1968 to determine the best high yielding variety and most suitable variety for growing in the dry season. The varieties tested were: (1) California Black eye, (2) Extra early Black eye, (3) Black eye Alabama, (4) Kwara ex-Kawoi, (5) Westbred (6556-2A), (6) Mala, and (7) Black eye Alabama-1239. Plot of a variety was split for treatments consisting of 0 and 2 cwts per acre of superphosphate. Average yield of all varieties of cowpea ranged from 56 lbs to 583 lbs per acre. Yield differences between varieties were highly significant. The variety Kwara ex-Kawoi gave significantly highest yield while Mala gave the lowest yield.

The effects of cowpea varieties on the yield of the rice crop which followed them showed that three cowpea varieties, namely, California Black eye, Black eye Alabama-1239 and Extra early Black eye gave increased yield of following rice which was significantly greater than those of the control and the remaining four varieties.

Herbicide Trials — In trials conducted at Badeggi over three years, Stam F-34, a selective post emergence herbicide, was used at the rates of 0, $4\frac{1}{2}$, 6, $7\frac{1}{2}$ lbs active ingredients per acre applied 2 weeks after transplanting rice and also at 9 lbs a.i. per acre applied in two equal sprayings of $4\frac{1}{2}$ lbs at 2 weeks and 8 weeks respectively after transplanting. The herbicide applications were compared with hand weeding subtreatments. A split plot design with four replications was used for the trial. The results indicated that the percentage of surviving weeds was significantly lower in the Stam F-34 treated plots supplemented by one hand weeding than those in the control (no Stam F-34 spray and no weeding). The weeds dominant in the rice fields prior to spraying were: (*i*) **Sphenoclea Zeaylendica,** (*ii*) **Cyperus** sp., (*iii*) **Echinochlos ratus,** (*iv*) **Ipomea acquatica,** (*v*) **Nyphea** sp; (*vi*) **Uticularia** sp. (*vii*) **Learsia lexandra** and (*viii*) **Scirpus prelongatus.** The efficacy of stam F-34 was evaluated on the basis of weed-counts 30 days after spraying.

The combined analysis of 3 years' data showed that yields were generally significantly greater in the weeded and non-weeded plots than in Stam F-34 treated plots. Also, Stam F-34 treated plots gave significantly higher yield than the control. Application at $4\frac{1}{2}$ lbs a.i. per acre at 2 weeks after transplanting gave significantly higher yield than control ($p=0.05$). However, use of the herbicide did not appear to be economically justifiable since it would cost the farmer about £8: 16s to £14: 14s per acre to obtain increased yields of 30.3 per cent as against only £3: 10s. per acre for two hand weeding with corresponding increase of 16.6 per cent over the control. The results of yields from Stam F-34 application in comparison with the control and the economics of the operation are given in Table 37:

Table 37: Average yield of Paddy, variety Mas 2401, obtained from Stam F-34 treatments and the related economics of operation compared with control.

Stam F-34 rates	*Weeding*	*No Weeding*	*% Decrease of yield over control*	*Extra cost per acre due to Stam F-34 application*
				£ s d
4½ lbs a.i. per acre	3352**	2718	—30.3	8 16 0
6 „ „ „ „	3201*	2386	—25.6	10 17 0
7½ „ „ „ „	3065*	2839	— 7.1	12 8 0
9 „ „ „ „ (4½ + 4½)	3473**	3397	— 2.2	14 4 0
Control No. Stam F	3186	2656	—16.6	3 10 0

*Significant difference over Control (p=0.05)
** Highly significant difference over Control (p=0.01)

In another experiment, started in 1968, weed control in swamp rice was studied in a split plot design with six replications to determine the rate, time and method of application of pre-emergent treatment of Gramavin (Dalapon) followed by post-emergent treatment with Stam F-34.

The main plot treatment was made up of twelve combinations of Gramavin (0, 7½ and 15 lbs a.i. per acre) combined with Stam F-34 (0, 3, 6, and 9 lbs a.i. per acre) and each plot was split for weeding and no weeding sub-treatments. The effects of pre- and post-emergent herbicide treatments are given in Table 38:

Table 38: Yields in lbs per acre from different treatments with interaction effects (Gramavin × Stam F-34) herbicidal interaction on weed control in swamp rice variety Mas 2401 at Badeggi.

STAM F-34 Applied as Post-emergence	*GRAMAVIN (DALAPON)*						
	No weeding			*Weeding*			
Rates	0 *lb/ acre*	7½ *lbs/ acre*	15 *lbs/ acre*	0 *lb/ acre*	7½ *lbs/ acre*	15 *lbs/ acre*	*Mean*
0 lb per acre	2889	2519	2490	2988	3671	3586	3024
3 lbs per acre	3189	3117	2915	2890	3644	3274	3171
6 lbs per acre	2575	3217	3269	2833	3644	3416	3159
9 lbs per acre	2803	3331	3317	3274	2907	3607	3206
Mean	2864	3046	2993	2996	3492	3471	
Means for Weeding *vs.* No Weeding 2968 → ← 3319 →							
L.S.D. for two means of Weeding/No Weeding treatments (P=0.05) 528.5							

The results indicate that there was no significant difference in yields due to Gramavin and Stam F-34 treatments. The pre-emergent and post-emergent spray treatments of Gramavin and Stam F-34 gave an overall increase in yield of rice but the differences were not significant. The yield averages for split sub-plots (weeding and no weeding) showed higher yield with weeding than with no weeding though differences were not significant.

THE LIBRARY AND INFORMATION DIVISION

The Division assumed its present name on 1st April, 1968 and the Records Section of the former Statistics and Records Division continued to be under the supervision of this Division until the arrival on 2nd December, 1968 of a Research Officer (in training) statistician, Mr A. Bamidurọ who was on transfer from the Federal Office of Statistics.

Reorganisation work continued and it was brought to an appreciable position at the end of the financial year. An *Annual Reports* section was created, the periodicals were arranged in alphabetical order on the shelves, reprints and pamphlets collections were organised and a *Duplicates for Disposal* section was also created.

Books and Periodicals: 82 books were purchased, both locally and from overseas, while a few titles were received as gifts. Thirty-seven periodicals titles were on standing order subscriptions with Crown Agents for Badeggi and 106 for Ibadan. Fifty-two volumes of periodicals were bound for Badeggi and 88 for Ibadan.

Photographic Section: The photographic section handled 131 requests and made 761 prints, 183 negatives, 34 microfilms, 60 Duostat copies and 21 photocopies. The Draughtsman handled 108 requests and prepared 84 copies of various plans, 56 graphs and 73 labels for use in the field, the laboratories, the museum and the various offices.

Publications: The Index of Agricultural Research, 1968/69, and three memoranda were published and distributed. The first two publications in the new series entitled *Departmental Information Papers* were issued by Messrs B.D.A. Beck and J.E.Y. Hardcastle in December 1968 and January 1969 respectively. The preliminary draft of *Publications of the Nigeria Agricultural Departments* 1910 *to* 1954 and of the *Federal Department of Agricultural Research*, 1954 *to* 1969 was completed on 30th September, 1968. Papers which appeared in scientific journals during the year are listed below:

ALUKO, M. O. (1968)
Microbial antagonism in the control of **Rhizoetonia solani** Kuhu on potatoes, Ph.D. Thesis, Univ. of Nottingham.

JERATH, M. L. (1968)
Notes on the biology of some short horned grass-hoppers from Eastern Nigeria (Orthoptera: Acridoidea) Proc. R. Ent. Soc. Lond. (a) **43** (1-3): 27-38.

JERATH, M. L. (1968)
Seasonal abundance and distribution of sugar-cane stem borers in Nigeria. J. Econ. Ent. **61** (3): 593-596.

OJEHOMON, O. O. (1968)
Flowering, fruit production and abscission in cowpea, **vigna unguiculata** (L.) Walp. Jour. W. Afr. Soc. Assoc. **13** (2): 229-236.

OJEHOMON, O. O., RATHJEN, A. S. and MORGAN, D. G. (1968)
Effect of day length on the morphology and flowering of five determinate varieties of **Phasiolus vulgaris** L. J. Agric. Sci; Camb. **71** (2): 209-214.

OJEHOMON, O. O. and MORGAN, D. G. (1969)
A quantitative study of inflourescence development in **Phasiolus vulgaris.** Ann Bot. **33** (130): 325-332.

ONUORAH, P. E. (1968)
The influence of sucrose and wheat root exudates on the germination and growth of conidia of **Fusarium culmorum** (W.G.S.M.) Sacc. Pl. Soil, **29** (1): 27-32.

WILLIAMS, A. (1969)
Effect of water management practice on the growth characteristics, grain yield and water requirement of rice. M.S. Thesis, Univ. of Phillippines.

Departmental Memoranda

No. 89 HARDCASTLE, J. E. Y. (1968)

A short review of soil fertility research on Nigeria.

90 WILLIAM, A. and BECK, B. D. A. (1968)
Preliminary results of rice fertilization in Jere Bowl, Maiduguri, Northern Nigeria.

91 AJOMALE, S. V. A. and UNNY, Mrs L. K. (1968)
A manual of entomology and nematology techniques (as used in the Entomology Division of the Federal Department of Agricultural Research).

PLANT QUARANTINE AND INTRODUCTION SERVICE

Plant Introduction and Post Entry Quarantine

Fifty-five consignments of plant materials were imported from various countries during the year by Government Agencies, Research institutions and individuals in the country. The lists of importation include graminacious seeds, vegetable seeds, citrus seeds, legume seeds, forest tree seeds, cocoa seeds, flower seed, sugar cane, cocoa, citrus and roses, vegetative materials.

During the period under review, eight consignments of plant materials were propagated under quarantine and these included tobacco seeds, rubber bud wood, sugar-cane cuttings, cocoa beans, mango and grape vine cuttings. All have been released to individual importers except sugar canes and grape vines which are still under observation in quarantine.

In addition to the general routine cleaning of the green houses and their surroundings, necessary repairs and renovation were regularly attended to. The imported plant materials propagated under quarantine in the green houses are being taken care of and periodically sprayed with Rogor against pest attack.

Pawpaw Collection and Indigenous Fruit Tree Collection Plots

Twelve new varieties of pawpaw were introduced and the pawpaw plots were further extended westwards by two plots. These were planted with two varieties of pawpaw (Pink solo and P649).

Index cards on the existing Indigenous Fruit Trees on A6 field have been completed. To date, forty trees are present in the field.

Nurseries B_6 and D_7: Besides routine horticultural care, other operations in the nursery were attended as follows:

(*a*) **Fertilizer Application:** Potash and sulphate of Ammonia were applied to the seedlings periodically. Required doses of micronutrients were supplied as and when it was necessary for the seedlings.

(*b*) **Pesticide application:** Seedlings were occasionally sprayed with *Gammalin* 20, Rogor and Bordeaux mixture against fungal or other pest attacks.

(*c*) **Buddings:** To date, three hundred Avocado pears and 200 Mangoes have been budded. About 258 citrus seedlings have also been budded. Four thousand five hundred seeds of citrus were raised in the pre-nursery which included 1800 Willow-leaf mandarine, 700 lake tangelo and 2,000 seeds of cleopatra mandarine.

Attempts were made to bud a number of rubber seedlings with scions from budwood imported from Liberia but the buddings were unsuccessful.

Supplies: (*a*) Some quantity of shaddock orange budwood and 20 Avocado seedlings were supplied to the Principal Agricultural Officer, Ministry of Agriculture and Natural Resources, Kwara State.

(*b*) Some mango budwood and avocado seedlings were supplied to the Horticulturist, Ministry of Agriculture and Natural Resources.

Permits: Four hundred Plant Import Permits were issued during the period at Lagos, Ibadan and Kano.

Plant Inspection: The total number of consignments of Plant materials inspected during the period was 3,258.

General plant inspection at Customs check points were carried out at the various centres, namely Airports at Ikeja and Kano; Quays at Marina, Apapa Wharf and Idiroko on land routes and Post Office Parcels Depot. During this period, stations at Calabar, Kaduna, Port Harcourt and Sapele were closed due to the civil war in the country.

Plant Exportation: Inspection of plant materials for export continued throughout the period. A total of 444 Phytosanitary Certificates were issued at Lagos, Ibadan, Kano and other authorized agencies at NIFOR, near Benin City, Institute for Agricultural Research, Samaru, Zaria and the Director of Forest Research, Ibadan.

Appendix I.— AN ANALYSIS OF THE ESTABLISHMENT, 1968-69

The authorised establishment of Senior Staff at the beginning of the year, and the actual strength at 31st March, 1969, are given below.

Administrative and Professional	*Establishment*	*Posts filled*	*Vacancies*
Director	1	1	—
Deputy Director	1	1	—
Principal Research Officers	5	4	1
Senior Research Officers and Research Officers	48	39	9
Librarian	1	1	—
Total, Administrative and Professional Staff	56	46	10

Executive (Technical)	*Establishment*	*Posts filled*	*Vacancies*
Higher Technical Staff			
Technical Officers	20	19	1
Asst. Technical Officers	19	17	2
Senior Lab. Technologist	1	1	—
Senior Technical Officer	1	1	—
Higher Laboratory Technologists	2	1	1
Higher Technical Officers	4	4	—
Asst. Laboratory Technologists	11	5	6
Mechanical Demonstrators	2	2	—
Laboratory Technologists	9	5	4
Total, Executive (Technical) Higher Technical Staff	69	55	14

Executive (Administrative)	*Establishment*	*Posts filled*	*Vacancies*
Principal Accountant	1	1	—
Higher Executive Officer	1	—	1
Executive Officer (General)	1	1	—
Executive Officers (Accounts)	1	2	—
Asst. Executive Officers (General)	2	2	—
Asst. Executive Officers (Accounts)	1	2	2
Library Officers	4	—	1
Personal Secretary	1	—	1
Total, Executive (Administrative)	12	8	5
Grand Total, Senior Staff	137	109	29

The authorised establishment of junior Staff at the beginning of the year, and the actual strength at 31st March, 1969 are given below:

Clerical	*Establishment*	*Posts filled*	*Vacancies*
Chief Clerk	1	1	—
Secretary Typist	1	1	—
Assistant Chief Clerks	2	2	—
First Class Clerks	11	9	2
Second Class Clerks	29	27	2
Library Clerks	2	2	—
Stenographer Grades I and II	2	2	—
Store-keeper Grade I	1	1	—
Store-keeper Grades II and III	7	7	—
Total, Clerical	56	52	4

Technical	*Establishment*	*Posts filled*	*Vacancies*
Senior Agric. Asst. Grade I	1	—	1
Senior Lab. Technician Grade II	1	—	1
Senior Agric. Asst. Grade II	4	—	4
First Class Agric. Lab. Technician	1	—	1
Agric. Assistant Grade I	18	13	5
Agric. Asst. Grades II and III	87	80	7
Second & Third Class Agric. Lab. Technicians	22	22	—
Senior Photographic Asst. Grade I	1	1	—
Draughtsman Grade II	1	1	—
Total, Technical	136	117	19

Minor Technical and Sub-Clerical	*Establishment*	*Posts filled*	*Vacancies*
Senior Field Overseers	6	5	1
Field Overseers Grades I and II	69	66	3
Artisans	36	37*	—
Drivers-Mechanic	12	12	—
Clerical Assistants	14	10	4
Typists	18	18	—
Lab. Assts. Grades I and II	4	3	1
Meteorological Recorder	1	1	—
Senior Laboratory Attendant	1	1	—
Laboratory Attendants	18	17	1
Stores Assistant	4	5*	—
Store Attendants	2	2	—
Senior Driver Mechanic	1	1	—
Telephone Attendants	3	3	—
Head Messenger	1	1	—
Messengers	18	18	—
Duplicating/Gestelith Machine Operator	1	1	—
Total, Minor Technical & Sub-Clerical	209	201	10
Grand Total, Junior Staff	401	370	33

Progress of Nigerianisation as at 31st March, 1969

Type of Post	*Nigerian*	*Expatriate*		*Vacant*	*Total*
		(P)	*(C)*		
Administrative and Professional	33	3	10	10	56
Executive (Technical)	55	—	—	14	69
Technical	117	—	—	19	136
Minor Technical	147	—	—	6	153
Executive (Clerical)	8	—	—	5*	12
Clerical	52	—	—	4	56
Sub-Clerical	54	—	—	4	58
	466	3	10	62	540

(P) = Pension (C) =Contract

* Shows over establishment.

Appendix II

ANNUAL REPORT ON METEOROLOGICAL DATA AT THE FEDERAL AGRIC. RESEARCH STATION MOOR PLANTATION, IBADAN. (JANUARY-DECEMBER 1968)

Station	*Months*	*Rain-fall in inches*	*10 Years Ave-rage in inches*	*No. of wet days*	*Cumu-lative Total in inches*	*Mean Relative Humi-dity %* 10.00 *a.m.*	*Maxi-mum Tempe-rature* 10.00 *a.m.* (°F)	*Minimum Tempera-ture* 10.00 *a.m.* (°F)	*Mean Tempera-ture* 10.00 *a.m.* (°F)	*Mean daily Duration of Sunshine in Hours*
	January	1.44	0.22	2	1.44	80	93	69	80.9	7.5
	February	0.47	0.84	1	1.91	77	97	72	84.7	7.1
Headquarters	March	4.86	3.23	10	6.77	82	94	72	87.5	6.9
Moor Plantation	April	2.65	4.99	11	9.42	83	91	73	81.8	5.2
	May	5.18	6.70	12	14.60	80	91	73	82.0	6.6
	June	6.80	9.53	18	21.40	86	87	72	79.4	5.0
Lat. 7.23°N Long. 3.51°E Alt. 574ft.	July	7.38	8.49	21	28.78	89	83	71	77.1	2.9
	August	5.02	6.10	20	33.80	89	83	71	77.0	2.4
	September	5.38	7.54	13	39.18	87	84	71	77.0	3.1
	October	8.77	6.56	19	47.95	85	87	70	79.6	6.1
	November	1.23	1.76	4	49.18	82	90	70	79.6	5.6
	December	0.00	0.38	NIL	49.18	79	92	72	82.3	5.2

ANNUAL REPORT IN METEOROLOGICAL DATA AT THE FEDERAL RICE RESEARCH STATION—1st JANUARY TO 31st DECEMBER, 1968

Appendix III

Station	*Months*	*Rain-fall in inches*	10 *years average in inches*	*No. of wet days*	*Cumula-tive total in inches*	*Mean Relative Humidity* % 10.00 *a.m.*	*Maxi-mum Temp.* 10.00 *a.m.*	*Mini-mum Temp.* 10.00 *a.m.*	*Mean Temp.* 10.00 *a.m.*	*Mean Daily duration Sunshine Hours*
Rice Research Station, Badeggi Lat. 9°045'N Long. 6°07'E Alt. 231.46 ft.	Jan.	0.07	0.33	1	0.07	63	90.5	62.9	76.5	7.70
	Feb.	0.00	0.23	—	0.07	53	96.8	66.1	81.2	8.98
	March	0.00	0.84	—	0.07	65	97.5	74.6	85.8	8.07
	April	3.02	2.43	8	3.09	70	94.9	75.5	84.9	8.06
	May	4.31	4.86	13	7.04	79	90.7	73.9	82.1	7.46
	June	6.04	7.66	17	13.44	82	87.4	73.1	80.1	6.26
	July	15.00	8.57	18	28.44	84	86.5	72.8	79.5	5.58
	Aug.	7.96	8.19	16	36.40	84	86.8	73.7	80.0	4.70
	Sept.	6.17	9.45	15	42.57	83	86.4	72.9	79.5	5.32
	Oct.	1.31	3.41	5	43.88	78	91.4	73.8	82.3	8.47
	Nov.	0.00	0.00	—	43.88	69	93.7	70.5	81.8	9.17
	Dec.	0.00	0.00	—	43.88	66	94.1	66.4	80.0	8.56
	Total	43.88	45.97	93	262.83	876	1096.7	856.2	973.7	88.33
	Mean	5.49	5.00	11	21.90	73	91.4	71.4	81.1	7.36

Appendix IV

RECOMMENDATIONS FOR IMPROVED MAIZE VARIETIES IN THE NORTHERN AND WESTERN STATES, YEAR 1969

Preamble

In 1964, the white dent variety Eafro 231 and the yellow flint variety NS-1 were recommended to the farmers in Nigeria. Since then, the maize breeders at the Federal Department of Agricultural Research at Ibadan have been working to select and develop maize varieties from the existing varieties with the aim of replacing the presently recommended types with higher yielding and more acceptable cultivars. The most promising maize varieties have been tested in the National Zonal Maize Variety Trials for a period of three years in the States. The recommendations made here are based on the results of those yield trials and other investigations on the farmers and consumers preferences for the maize varieties.

The Foundation Seed of the recommended varieties will become available to the farmers for planting in the early season of 1970. Federal Department of Agricultural Research will ensure that the State Agricultural Agencies get these for further multiplication for distribution to the farmers in the States.

RECOMMENDATION

STATES	*Varieties*	*Mean yield lbs/acre*	*% Superiority over Local*	*% Superiority over Eafro 231*	*Days to tassel-ling*	*% floury content*	*Description of Grain types*
Kwara State	NS-1 (Improved)	2449	93	62	56	88	Yellow, flint.
	NS-5	1911	50	26	54	86	White, floury-flint dent.
	Diacol-V-153	1769	47	17	56	88	White, flint.
North-Western State	NS-1 (Improved)	5118	117	24	56	88	Yellow, flint.
	H.503	4417	87	6	60	83	White, dent.
	NS-5	3963	68	—	54	86	White, floury-flint dent.
North-Central State	NS-1 (Improved)	5726	26	42	56	88	Yellow, flint.
	NS-5	5156	13	28	54	86	White, floury-flint dent.
	Diacol-V-153	4849	6	20	56	88	White, flint.
South-Eastern State	NS-1	4664	29	8	56	88	Yellow, flint.
	Diacol-V-153	4434	44	3	56	88	White, flint.
	NS-5	4190	16	4	54	86	White, floury-flint dent.
Benue-Plateau State	NS-1	2711	68	45	56	88	Yellow, flint.
	Diacol-V-153	2359	46	26	56	88	White, flint.
	NS-5	2237	39	20	54	86	White, floury-flint dent.
Western State (including Lagos)	NS-1 (Improved)	2990	43.5	NA	56		Yellow, flint.
	NS-5	2865	37.5	NA	54		White, dent.
	H.507	3235	55.3	NA	60		
	Diacol-V-153	3144	51.0	NA	56		White, flint.
Midwestern State	NS-1 (Improved)	2462	82.2	NA	56		Yellow, flint.
	NS-5 (Floury)	1988	47.0	NA	54		White, floury-dent.
	Diacol-V-153	2254	66.8	NA	56		White, flint.

Appendix V

RECOMMENDATIONS FOR IMPROVED SWAMP RICE VARIETY YEAR OF RECOMMENDATION 1969

Crop: RICE

Recommendation

The swamp rice variety SML-140-10 is recommended to replace the currently recommended variety of five months duration, Variety Mas 2401, in the irrigated rice areas of Northern Nigeria where water control is provided.

Basis of recommendation

In 1965, a series of new varieties were introduced from Surinam and grown in the Variety Collection at Badeggi. Four of these varieties, referred to as the SML lines, had an erect habit with short straw and narrow, erect dark green leaves. They all showed very high resistance to lodging and had long A-type grain of very high quality. In planting date trials conducted between 1965 and 1968 at Badeggi, the varieties proved to be weakly photoperiod sensitive with an average duration of 145 days which is almost two weeks earlier than Mas 2401.

Yield: The four SML lines, which are numbered SML-140/5, SML-140/10, SML-81-13 and SML-352 were compared in an experiment repeated in 1966, 1967 and 1968, with the standard swamp rice variety Mas 2401 and nineteen other introduced medium duration swamp rice varieties selected from the variety collections at Badeggi. Similar trials were conducted between 1966 and 1968 at six centres in Nigeria. The yields of the SML lines are compared with Mas 2401 at six centres in Table 7 below. The data at Badeggi represents the average of three years trials and the data from Abakaliki and Bende represents the data from two years trials. The data from Wurno, Bakura, and Yola was obtained in 1968, *i.e.* one year trial.

The Yield of five varieties of shallow swamp rice at six centres in Nigeria (Yields in lbs/acre)

Variety	Station						
	Badeggi	*Bende*	*Abakaliki*	*Wurno*	*Bakura*	*Yola*	*Mean*
SML140/10	2,880	2,060	4,980	3,900	3,960	3,680	3,580
SML 140/5	2,220	3,810	5,690	3,020	3,430	2,690	3,480
SML-81-13	2,460	2,740	3,730	3,560	2,700	3,130	3,050
SML-352	1,960	3,100	3,670	2,370	3,170	3,500	2,960
MAS 2401	1,740	2,330	1,850	3,480	3,560	3,400	2,720
Mean	2,750	2,810	3,980	3,270	3,360	3,280	

* Note that the value 3170 for SML-352 at Bakura is calculated using the missing plot technique.

The variety SML-140/10 gave significantly higher yields than Mas 2401 at all Stations except Bende, where the varieties were not planted in a statistical layout. SML-140/10 produced an average yield of 3,580 lbs per acre, an increase of 32 per cent over the average yield of 2,720 lbs per acre produced by Mas 2401.

Milling Quality: The milling quality of SML-140/10 is very good. When soaked in cold water for 48 hours and parboiled for half an hour and dried in the shade to a moisture content between 11 to 12 per cent, the average-percentage of broken grains in a single stage milled sample is about 14 per cent, but this can further be decreased by following the method of soaking the SML-140/10 paddy in warm water for 6 to 7 hours at 70°C and parboiling it for 15 minutes and then drying it in the shade to 11 to 12 per cent moisture content before milling. The percentage of broken grain after two-stage milling is reduced to 8.5% giving an out-turn of about 92 per cent of whole grain.

SML-140/10 has been found to be the most suitable high yielding, early maturing, non-lodging swamp rice variety available at the present time and it is recommended to replace the present standard variety Mas 2401. It is stressed that to obtain the maximum milling out-turn and highest market price from SML-140/10, two-stage milling produces the best quality product.

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